REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	5.Sep.02	THESIS

4. TITLE AND SUBTITLE
LONG-TERM FOLLOW-UP OF CLASS II ADULTS TREATED WITH ORTHODONTIC CAMOUFLAGE: A COMPARISON WITH ORTHOGNATHIC SURGERY OTCOMES

5. FUNDING NUMBERS

6. AUTHOR(S)
MAJ MIHALIK COLIN A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
UNIVERSITY OF NORTH CAROLINA

8. PERFORMING ORGANIZATION REPORT NUMBER
CI02-524

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
THE DEPARTMENT OF THE AIR FORCE
AFIT/CIA, BLDG 125
2950 P STREET
WPAFB OH 45433

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Unlimited distribution
In Accordance With AFI 35-205/AFIT Sup 1

12b. DISTRIBUTION CODE

DISTRIBUTION STATEMENT A:
Approved for Public Release -
Distribution Unlimited

13. ABSTRACT *(Maximum 200 words)*

20021029 018

14. SUBJECT TERMS	15. NUMBER OF PAGES
	99
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

THE VIEWS EXPRESSED IN THIS ARTICLE ARE THOSE OF THE AUTHOR AND DO NOT REFLECT THE OFFICIAL POLICY OR POSITION OF THE UNITED STATES AIR FORCE, DEPARTMENT OF DEFENSE, OR THE U.S. GOVERNMENT

"LONG-TERM FOLLOW-UP OF CLASS II ADULTS TREATED WITH ORTHODONTIC CAMOUFLAGE: A COMPARISON WITH ORTHOGNATHIC SURGERY OUTCOMES"

By

Colin Antony Mihalik, DDS

A thesis submitted to the faculty of The University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Science in the Department of Orthodontics in the School of Dentistry.

Chapel Hill

2002

Approved by:

_____//signed//_____ **Advisor**
William R. Proffit, DDS, Ph.D.

_____//signed//_____ **Reader**

L'Tanya Bailey, DDS, MS.

_____//signed//_____ **Reader**
George Blakey, DDS

ABSTRACT

Colin Antony Mihalik: Long Term Follow-up of CL II Adults Treated with Orthodontic Camouflage: A Comparison with Orthognathic surgery outcomes. (Under the direction of Dr. William R. Proffit, DDS, PhD)

Thirty-one adults who had been treated with orthodontics alone for Class II malocclusion were recalled at ≥5 years post-treatment, for evaluation of cephalometric and occlusal stability and satisfaction with treatment outcomes. These were compared to similar data for long-term outcomes in patients who had surgical correction. Small mean changes in skeletal landmark positions did occur long-term, but were in general much smaller than in the surgery patients. The percentage of patients with a long-term increase in overbite was almost identical in the orthodontic and surgery groups, but Class II surgery patients (who had more severe problems initially) were nearly twice as likely to have an increase in overjet long-term. The patients' perceptions of outcomes were highly positive in both the orthodontic and surgical groups. The camouflage patients reported fewer functional or TM joint problems than the surgery patients, and had similar reports of overall satisfaction with treatment.

ACKNOWLEDGEMENTS

I would like to thank the following people for their contributions in making this research project possible:

Dr. William R. Proffit for his constant guidance, support, patience and most of all his incredible ability to transfer knowledge in an easily understood "pooh bear" style.

Dr. L'Tanya Bailey for her always calm and reassuring thoughts and words and her constant watch to ensure that all her residents succeed.

Dr. George Blakey for his surgical expertise and encouragement.

Dr. Ceib Phillips for her amazing knowledge of the unknown statistical world and for helping me sort out what is relevant and irrelevant.

Ms. Debbie Price for her work on my data. She worked tirelessly to get my data into Dolphin when the VAX was no longer an alternative. Additionally, for all her help with running the stats and then having to answer my multitude of questions.

Ms. Lyna Rogers and Dr. Tulloch for their help in scoring all my PAR models and then helping come up with the "picture PAR"

Mr. Mark Kaley for his help in sorting through all the old charts to see who meet the criteria and then helping to sort through the dusty attic finding models for our patients.

Finally I would like to thank my wife, and my daughter. You two make life worthwhile and without your constant encouragement and smiles I could not have done it. I love you.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

LIST OF APPENDICES

INTRODUCTION

For non-growing individuals with moderate to severe skeletal Class II malocclusions, there are only two possible treatment plans: orthodontic camouflage (based on retracting the protruding maxillary incisors) or orthognathic surgery (mandibular advancement and/or superior positioning of the maxilla). Recently, with recall of Class II surgery patients at 5 years or longer post-treatment, it has been observed that surprisingly large skeletal changes occur long-term (beyond one year post-surgery) in 20-30% of this group. It appears that growth in the original pattern and remodeling of the mandibular condyles can occur long after surgical healing has been completed. For most of these patients, the skeletal changes are greater than the changes in the dental occlusion, i.e., dental compensation for the skeletal changes often occurs, so clinical relapse is rare.

Although Schubert et al [1] looked at skeletal remodeling in non-surgical patients long term, they did not specifically look at camouflage patients, and thus there are no comparable data for long-term stability after orthodontic camouflage of Class II problems in adults. It is not known whether similar long-term growth, condylar remodeling and dental compensations occur in these camouflage patients as was seen in surgical patients.

Skeletal stability is evaluated from cephalometric radiographs. Changes in the dental occlusion after Class II treatment usually focus on overjet, which can be

measured directly from the patient or from dental casts. A more thorough way to evaluate changes in the dental occlusion is the PAR method developed by Shaw et al in England.[2,3] This provides a weighted measure of the occlusion that takes into account overjet, overbite, midlines, buccal occlusion and upper and lower anterior alignment. In evaluating treatment outcomes, it is important to note not only the "objective" changes measured from radiographs and other records but also the patients' perceptions. These pieces of data can be obtained from structured interviews and questionnaires.

This project had three goals: (1) to compare long-term skeletal and soft tissue changes in the orthodontic and surgery groups, based on cephalometric radiographs; (2) to evaluate long-term changes in occlusal relationships in adults who had orthodontic treatment for Class II malocclusion, using the PAR system, and to compare occlusal stability to surgery patients; and (3) to evaluate patient satisfaction following orthodontic treatment, using the same patient-centered surveys that previously have been used with surgery patients.

The outcomes are presented in conjunction with an extended literature review, a paper for publication, and multiple indices containing extensive data from which the publication was derived.

1. EXTENDED LITERATURE REVIEW

Class II Malocclusion: General Background

Class II malocclusion is seen as an underdevelopment of the mandible and protrusion of the maxillary incisors. No other dentofacial deformity occurs as frequently as a Class II malocclusion with somewhere between 15-20 % of the American population being afflicted.[4, 5] The functional problems of a severe Class II malocclusion include a large incisor overjet and often seen deep bite which makes incising difficult unless protruding the mandible. Additionally, our societal preference for a strong chin has been documented in the literature, and it seems that a weak chinned individual carries a negative connotation to others (i.e. the village idiot) and this may have real social and economic consequences for the patient. [6]

If a discrepancy in the size or position of the jaws contributes to the malocclusion and is reflected in improper facial proportions, there are only three possible treatments: (1) modification of growth, (2) orthodontic camouflage (displacing the teeth to obtain correct dental relationships in spite of the jaw deformity), which produces a dental compensation for the skeletal discrepancy, or (3) surgical repositioning of the jaws and/or dentoalveolar segments. If the patient is older and has little to no growth remaining, this often only leaves options 2 or 3, since the opportunity for growth modification to correct the skeletal Class II malocclusion has been missed.

Relatively little data exists for the prevalence of facial characteristics, so it is necessary to infer the presence of jaw deformities from data on dental occlusal relationships. Fortunately, we can get an appreciation for the types of dentofacial problems from existing data on dental occlusion and the jaw relationships that presumably underlie them. In the large-scale evaluation of the health of the US population carried out in 1989-1994 (National Health and Nutrition Estimates Survey, NHANES III), [7] estimates of malocclusion were obtained from a sample of 14,000 individuals. This sample provided weighted estimates for the approximately 150 million people in white, black and Mexican-American racial/ethnic groups between the ages of 8 and 50. Those outside that age range, Native Americans, those living on military reservations, and some other specific population groups were not studied. Data for alignment of incisor teeth, overjet / reverse overjet, vertical overlap of incisors, and presence of posterior crossbite and maxillary midline diastema were collected. [8] From Proffit and White, [7] we can presume that >10 mm overjet reflects a skeletal Class II problem. The same thinking applies to reverse overjet >4 mm, which indicates a skeletal Class III relationship with some combination of maxillary deficiency and mandibular excess. Most of those with 2-3 mm reverse overjet also would have skeletal problems. In the vertical plane of space we can presume that the prevalence of open bite >4 mm indicates the prevalence of the long face deformity pattern—the small number of severe open bites without excess face height would about balance the number of long face individuals with minimal or no open bite.

The NHANES III data are summarized by Proffit and White, [7] as indicating that approximately 2% of the US population have mandibular deficiency and/or vertical

maxillary excess severe enough to be handicapping (the 0.3% with >10 mm overjet, plus half the 3.8% with 7-10 mm overjet). About 0.3% have mandibular excess and/or maxillary deficiency this severe (0.1% with >4 mm reverse overjet, plus half the 0.5% with 3-4 mm); about 0.3% have a long face deformity (0.1% >4 mm open bite, plus half the 0.5% with 3-4 mm). Because vertical and antero-posterior problems frequently occur in the same individual, it is necessary to add only one-third of the long face group to the total for dentofacial deformity. Asymmetry and other problems occur rarely, but might contribute 0.1% to the total. It appears, therefore, that approximately 2.5% of the US population have facial disproportions and severe malocclusions that would put them into the dentofacial deformity category. It has been estimated previously that about the worst 5% of those who seek orthodontic treatment fall into this category. Since about 50% of American children are judged to need orthodontics, this appears to be correct. [7]

Treatment Alternatives for Class II Malocclusion

For mild Class II problems, orthodontics alone obviously is the preferred treatment; for the most severe ones, surgery obviously is required; but there are many patients in a borderline area for whom either approach might be used. The decision can be difficult, especially if the patient no longer has growth available. The treatment then is based on two considerations: the esthetic impact of orthodontics versus surgery, and the long-term stability of these approaches.

A. Orthodontic Camouflage Treatment

Extractions in conjuction with orthodontics have been a continuing point of contention among orthodontists. Edward Angle was the premier nonextractionist, believing that orthodontics was the ideal "bone growing machine" and thus the teeth could be expanded and bone would grow to support the expanded dentition.[4] Today we realize that the face is judged not on hard tissue relationships but rather on soft tissue contours and that patients are judged on what is seen. Thus the alignment of the incisors is important but so too is the relationship of the teeth to the lips, nose and chin, and of those structures to each other. [9]

Extracting maxillary premolars, often referred to as a camouflage pattern, can get the teeth to fit. It is possible to get the correct incisor, cainine and premolar relationships by extracting maxillary premolars, while leaving the molars in a full cusp Class II occlusion. This method of treatment gained in popularity in the 1930's and 1940's when a full appreciation of continued growth of the face was not available and soft tissue concerns were not as apparent. These were the days of getting the dental casts to fit well, and often it was forgotten that a patient lived with these teeth. Additionally, surgery was not available and in order to improve a severe overjet, something had to be done. The orthodontist was limited in what could be done within the framework of the skeletal pattern the patient presented with.

Today this type of camouflage treatment is best suited for the mild to moderate Class II patient, with little to no growth remaining. The risks involve over-retraction of the maxillary incisors to compensate for a deficient mandible and ending up with an obtuse nasiolabial angle and a compromised soft tissue profile. This orthodontic

treatment may also include excessive proclination of the mandibular incisors as Class II elastics are overused to attempt to decrease the overjet, causing both an unstable situation and stressing the labial periodontal support. Additionally, extended appliance wear and detrimental periodontal and root resorption effects can be seen. [10] Extended Class II elastics can rotate the occlusal plane, causing extrusion of the maxillary incisors and rotating the mandible down and back. If however the correct patient is selected, with overjet caused by maxillary protrusion, an acute nasiolabial angle, and a mandible that is close to normal length with a mild to moderate Class II skeletal pattern, successful camouflage treatment can be obtained. Camouflage also works in mild to moderate Class II patients who are past their pubertal growth spurt but still have some growth remaining. This type of treatment can work in adults but is more difficult due to the lack of any vertical growth that would counteract the extrusive forces of orthodontics. [11]

B. Surgical Treatment of Skeletal Class II Malocclusion

Orthognathic surgery has the advantage of correcting the underlying skeletal problem without having to compromise the soft tissue. Often, however, the dentition has compensated for the original skeletal discrepancy and so must be decompensated before the surgery. This decompensation often requires removal of teeth to maximize the surgical movement, and so in a way compromises a full dentition of teeth to maximize the soft tissue profile.

Three main surgical options are used today to deal with skeletal Class II patients: [7]

(1) Advancing the deficient mandibular body, which is used in about 2/3 of skeletal Class II patients. This is indicated when a mandibular body deficiency is the prime cause of the mismatch in jaw relationships.

(2) Maxillary impaction to allow the mandible to auto-rotate into a more anterior position. This procedure is used in approximately 1/3 of skeletal Class II patients, either alone (15%) or in conjunction with mandibular surgery (20%). This surgery is primarily used when a vertical overgrowth of the maxilla has occurred causing the mandible to rotate down and back.

(3) Masking procedure by a genioplasty to advance the chin region by itself or in conjuction with either of the 2 above. This procedure can also be used with orthodontic only cases to help improve the holdaway ratio and give a stronger chin projection.

Although these 3 options are used today, retraction of the anterior portion of the maxillary alveolar process and teeth was used in the past before the surgical techniques for mandibular advancement surgery became popular. This surgical camouflage treatment was very unesthetic, making a maxilla match with an already deficient mandible. Luckily, we now look at the soft tissue profile and surgery is done on the jaw with the deficiency and only for the more severe cases, thereby maximizing the esthetic value. However, surgery is not without additional risks including:

(1) Difficulties with anesthesia from minor interbation/extibation problems all the way to hyperthermia and death.

(2) Complications with surgery, including infections, loss of blood supply and long term paresthesia.

(3) Relapse of the surgical changes.

The long-term changes of Class II patients treated surgically have been studied, but little is known about the long-term stability of camouflage treatment. Shubert et al. noted that normal adult growth could not account for the long-term (5 year) changes observed following orthognathic surgery. [1] Facial growth does continue at a slow rate in the adult. How this growth affects camouflage treatment, orthognathic surgery, routine orthodontics or even no treatment is just now beginning to be understood. Isreal showed that the cranial skeleton increased 1% per decade in all dimensions. [12] Behrents has also clearly shown that patients continue to grow in their original growth pattern, which could lead a CL II treatment towards relapse. [13] So the question must be asked: How stable is orthodontic camouflage in the long term? Specifically what changes are seen 5 years out of treatment and are these results any different than those seen in the 5-year surgery group? The important clinical question will be whether the camouflage is successful in terms of being esthetically acceptable, and if the greater improvement produced by surgery is worth the greater cost and risk of surgery.

Evaluation of Treatment Outcomes

A. Surgical Stability Literature

The stability of orthognathic surgery has been studied extensively in the last few years and a hierarchy of stability has been offered. [14] Key factors in surgical

stability include the direction of movement, the type of fixation and the surgical technique employed. As it turns out, the surgical movements most conducive to Class II correction, (maxilla up and mandible forward or a combination of both), happen to make up three of the top four most stabile surgical movements. Thus Class II surgery is and can often be a very successful procedure.

The long-term stability of most orthognathic surgical procedures has not been studied as intensely as the short-term result. Simmons et al found with normal or short face height and mandibular deficiency, there was a small (0.9mm) but statistically significant decrease in mandibular length from condylion to point B from 1 to 5 years post surgery. [15] In two of their 35 patients, the shortening was more than 4mm, but only one of the patients had more than a 2mm increase in overjet. Miguel et al also found that long term shortening of the condylion-pogonion length of 2-4mm may occur with modest clinical relapse beyond 1-year post surgery in 5-10% of two-jaw surgery patients. [15] Schubert et al found that both surgical patients and untreated adults had small skeletal changes over 5 years during early adulthood; the changes for the jaw surgery groups were larger than what normal adult growth would predict. In some instances, the postsurgical changes leading to relapse continue much longer than would be expected with healing form surgery. [1]

In the master's thesis of Petra Schubert Tilley and in her article entitled: Long-term cephalometric changes in untreated adults compared to those treated with Orthognathic surgery, [1] 33 adult patients (26 who had orthodontic treatment, and 9 who needed surgery but declined) were compared to 118 patients who had Orthognathic surgery. To evaluate whether these changes are greater in patients with

similar morphology who did not have surgery, long-term (5-year) changes in hard tissue landmarks were examined in 33 untreated (surgically) adults and compared to long term-term changes in skeletal class II surgery patients who underwent maxillary impaction, mandibular advancement, or both. She concluded that normal adult growth could not account for the long-term changes observed following jaw surgery. The question we need to ask: Is this also true for Class II camouflage patients?

B. Orthodontic Stability Literature

In a previous study from UNC, 33 non-growing skeletal CL II patients with premolar and orthodontic camouflage were compared with 57 similar patients treated with mandibular advancement and orthodontics at one year out of treatment. [17] The determination of treatment effects used Little's irregularity index for the incisors, [18] and overjet was measured as for NHANES III. [19] The results showed that both orthodontic and surgical-orthodontic treatments improved the malocclusion as judged from the casts. Additionally, looking at the treatment efficacy of the models data and the cephalometric numbers, it was noted that surgery resulted in greater reduction of overjet and greater improvement in most cephalometric skeletal, dental and soft tissue criteria. In the determination of esthetic changes, a panel of judges including orthodontists, maxillofacial surgeons and both respective residents viewed both simultaneous frontal and profile slides of before and after treatment. Before treatment the surgical patients had lower esthetic ratings, but after treatment they improved while the orthodontic only group were unchanged. The surgical patients had improved, but not to the pretreatment level of the orthodontics patients.

For Class II patients beyond the adolescent growth spurt there are only 2 options to correct the malocclusion: orthodontic camouflage to reposition the teeth to correct the occlusion and camouflage the underlying skeletal discrepancy or orthognathic surgery to correct the maxillo-mandibular relationship. However, how to decide which is the correct choice for a specific patient is always the difficult decision, especially since few guidelines suggest when surgery is necessary. Proffit and White, [20] used the "envelope of discrepancy" to indicate the limits of orthodontic treatment. Additionally, Proffit et al suggested surgery would be needed when overjet was greater than 10mm, especially if the distance from pogonion to Nasion perpendicular is 18mm or more and mandibular body length is less than 70mm, or facial height is greater than 125mm. [21] Additional help was provided by Medland's master's thesis [22] in which she proposed using a two or four variable model to predict if surgery would be needed. The model was based on easily measured, reproducible and commonly used factors. The specific factors were overjet, and ANB angle (in the 2 variable model), and added mandibular body length and anterior total face height in the 4 variable model. Overall the 2 variable model correctly classified patient 77 percent of the time, while the four variable model correctly identified the groups 81.5 percent of the time. All of these studies have given us a better idea of what factors are beyond orthodontic camouflage treatment, but we still have no good data as to the differences in long-term stability between the 2 types of procedures. Thus this study will attempt to offer data to help make an informed decision as to the long-term stability of camouflage treatment.

C. PAR Scores

A more thorough way to evaluate changes in the dental occlusion is the PAR method developed by Shaw et al in England.[2,3] This provides a weighted measure of the occlusion that takes into account overjet, overbite, midlines, buccal occlusion and upper and lower anterior alignment. Both occlusal and skeletal stability are important in comparing treatment outcomes. Al Yami et al used PAR scores to evaluate the orthodontic treatment outcomes in 564 adolescent patients (mean age of 12.0 years $\pm$ 3.1 years at the start of treatment) with a variety of problems, 10 years out of treatment.[23] Their results showed that about 2/3rds of the achieved orthodontic correction still was present 10 years after treatment. When PAR scores increased after treatment, about half of the change occurred within the first 2 years. Otuyemi et al used PAR scores to characterize the relative success of orthodontic treatment in adolescent Class II patients, and found on recall that 60% remained in the same category at 1 year and 38% at 10 years. The major factors in increasing scores were an increase in overjet and deterioration of lower anterior alignment.[24]

D. Perception Information

The major reason patients seek treatment for dentofacial problems is to overcome social handicaps created by an abnormal facial appearance. Functional impairments such as difficulty in chewing food, discomfort and pain (especially from temporomandibular dysfunction) also are important reasons for treatment, but often these are less important than the effect of facial appearance in social interactions and the feelings of inadequacy and discontent that this creates for the patient.[25, 26] Recent

data show that between one-third and one-half of the patients referred for evaluation in the UNC Dentofacial Clinic have high levels of psychologic distress, high enough to predict continuing problems in interpersonal relationships and significantly affect overall quality of life.[25] So overall, jaw function and facial appearance rather than dental occlusion are patients' major concerns.

According to Proffit and White, [7] it is fair to say that the major reason for treatment of dentofacial problems is to improve the quality of life. To do that, not only the physical attributes of the condition but also its impact on the patients' feelings and perceptions must be evaluated. A major reason for seeking correction of dentofacial problems is to improve facial appearance and thereby reduce social handicaps. Approximately two-thirds of those who seek treatment say that their appearance is a reason for doing so. Not quite half also have concerns about jaw function, and nearly one-third report pain and discomfort as a reason. [25,27] Proffit noted that a higher proportion of severe Class III and/or long face patients are seen for consultation in the Dentofacial Clinic at UNC than one would expect from their proportion in the general population, while the number with severe mandibular deficiency seeking treatment is lower than expected.[28] This probably reflects the fact that mandibular deficiency is much more common than the other patterns of disharmonies, and especially for women, more acceptable because of the baby face stereotype. Not surprisingly, many more women than men seek treatment for Class III problems, because that stereotype is more acceptable in men. It is interesting that the gender distribution is almost equal for the long face pattern. Given that women are more likely to seek treatment in general, this indicates that a long face is as much or

more of a handicap to men as to women. How the problem is perceived by the patient is of great importance. Individuals who perceive their condition as outside the normal range are more likely to seek treatment, and more likely to accept it if it is offered than those who perceive themselves as being normal or close enough to normal.[29, 30]

It seems reasonable that patients who accept treatment, particularly surgical treatment, would have a different set of motives for treatment or different expectations for change than those who do not. To test this hypothesis, Kiyak and co-workers developed a measure of patient expectancies based on the Subjective Expected Utility (SEU) theory of decision making. This theory assumes that an individual's likelihood of choosing a particular behavior (such as a decision about treatment) is determined by the weight he or she attributes to values (subjective utilities) associated with that behavior. From the18-point scale developed for use with dentofacial patients, only five items (cost, family or friends' advice, advice of a dental professional, appearance of teeth and appearance of profile) were necessary to predict with 80% accuracy whether a patient would accept treatment (surgery and/or orthodontics) versus no treatment.[31] Patients who made a decision to accept treatment found the costs to be manageable, received support in this decision from friends and/or family, and expected improvement in dental and facial appearance. For those who did not accept treatment, cost was the major factor in most instances, but negative comments about treatment from family and friends (or a dentist) also often played a role. It is interesting that the extent of the problem, as judged from cephalometric radiographs, was remarkably similar in those who did and did not

accept treatment. [32] Their perceptions, and perhaps their levels of psychological distress, were what was different.

A second major decision for those who do accept treatment is the choice between orthognathic surgery to correct a jaw disproportion and orthodontics and/or facial plastic surgery to camouflage it. Orthognathic surgery is generally perceived as riskier and more expensive than orthodontic camouflage. Not surprisingly, this decision is influenced by many of the same factors that were important in deciding whether to have treatment at all, but their ranking and relative importance are different. And, again, the clinical extent of the problem was remarkably similar between the two treatment groups even though ratings of attractiveness by peers and professionals differed significantly. [33]

In a recent study, perceptions of facial features were evaluated in 182 college students who served as controls, 63 parents or friends of orthodontic patients, and 92 patients being treated for dentofacial problems, 25 of whom had chosen orthodontic camouflage only.[34] As expected, there were no differences in the feelings of the four groups about their hair, forehead, ears, eyes, nose, cheeks or neck. The surgery patients, on average, felt more negative about their mouth, chin, profile and smile than the other three groups. Both groups who chose treatment were more negative about their teeth than the students or parents/friends groups, but the orthodontic camouflage group felt even more negative about their teeth than the surgery group. About 50% of those who accepted surgery felt disadvantaged socially by their appearance, and indicated that those feelings influenced their decision for treatment.[35] Compared to patients who chose camouflage orthodontics, approximately 1.5 times as

many patients who chose a surgery option reported that self-image issues, appearance and feelings about themselves, and oral function, were strong motivations for treatment.[25] Thus rather abstract factors seem to play a major role in patients' decisions about types of treatment and willingness to select more extensive, riskier and more expensive treatment.

Purpose of Present Study

The purpose of this study was to compare dental changes as measured with the PAR score from dental study casts of the orthodontic camouflage group from the time of completion until the 5-year or greater follow-up; to compare the skeletal and soft tissue changes as measured from the lateral cephalometric radiographs of the orthodontic camouflage group from the time of completion until their 5-year follow-up; to evaluate the patient satisfactions with the patient centered surveys matched against the data from CL II surgical patients.

REFERENCES: LIST FOR EXTENDED LITERATURE REVIEW

1. Schubert P, Bailey LJ, White RP, Proffit WR. Long-term Cephalometric changes in untreated adults compared to those treated with Orthognathic surgery. Int J Adult Orthod Orthognath Surg.1999;14:91-99.

2. Richmond S, Shaw WC, Roberts CT, Andrews M. The PAR Index (Peer Assessment Rating): Methods to determine outcome of orthodontic treatment in terms of improvement and standards. Eur J Orthod. 1992;14:180-7.

3. Richmond S, Shaw WC, Andrews M, Roberts CT. The Development of the PAR Index (Peer Assessment Rating): Reliability and Validity. Eur J Orthod. 1992;14:125-139.

4. Proffit WR. Contemporary Orthodontics. 3rd ed. St Louis, MO: Mosby; 2000: Ch #1, 3-4.

5. Kelly JE, Harvey C. An Assessment of the teeth of youths 12-17 years. Washington DC, National Center for Health Statistics, USPHS, PHS Pub. 1000-series 2, No 25. 1977.

6. McDonnell JP, McNeill RW, West RA. Advancement genioplasty: a retrospective cephalometric analysis of osseous and soft tissue change. J Oral Surg. 1977;35:640.

7. Proffit WR, White RP, Sarver DM. Contemporary treatment of dentofacial deformity. St. Louis, MO: Mosby; 2002.

8. Brunelle JA, Bhat M, Lipton JA. Prevalence and distribution of selected occlusal characteristics in the US population. J Dent Res. 1996;75:706-713.

9. Proffit W. The soft tissue paradigm in orthodontic diagnosis and treatment planning: A new view for a new century. J Esthetic Dent. 2000;12:46-50.

10. Kaley JD, Phillips C. Factors related to root resorption in edgewise practice. Angle Orthod. 1991;61:125-131.

11. Proffit WR. Contemporary Orthodontics. 3rd ed. St Louis, MO: Mosby; 2000: Ch #8, 276-278.

12. Israel H. Continuing growth in the human cranial skeleton. Arch Oral Biol. 1968;13:133-137.

13. Behrents RG. A Treatise on the Continuum of Growth in the Aging Craniofacial Skeleton. Ann Arbor: Univ of Michigan Center for Human Growth and Development, 1984.

14. Proffit WR, Turvey TA, Philips C. Orthognathic surgery: A hierarchy of stability. Int J Adult Orthod Orthognath Surg. 1996;11(3):191-204.

15. Simmons KE, Turvey TA, Phillips C, Proffit WR. Surgical-orthodontic correction of mandibular deficiency: Five-year follow-up. Int J Adult Orthod Orthognath Surg. 1992;7:67-79.

16. Miguel JA, Turvey TA, Phillips C, Proffit WR. Long-term stability of two-jaw surgery for treatment of mandibular deficiency and vertical maxillary excess. Int J Adult Orthod Orthognath Surg. 1995;10(4):235-245.

17. Proffit WR, Phillips C, Douvartzidis N. A comparison of outcomes of orthodontic and surgical-orthodontic treatment of Class II malocclusion in adults. Am J Orthod. 1992;101(6): 556-65.

18. Little RM. The irregularity index: a quantitative score of mandibular incisor alignment. Am J Orthod. 1975;68:554-63.

19. Proffit WR, Phillips C. Proposal for N-HANES III survey training manual: measurement of malocclusion/dentofacial characteristics. Chapel Hill; University of North Carolina Department of Orthodontics, 1988.

20. Proffit WR, White RP Jr. Who needs surgical-orthodontic treatment?. Int J Adult Orthod Orthoognath Surg. 1990;5:81-90.

21. Proffit WR, Phillips C, Tulloch JF, Medland PH. Surgical versus orthodontic correction of skeletal Class II malocclusion in adolescents: Effects and indications. Int J Adult Orthod Orthoognath Surg. 1992;7(4):209-220.

22. Medland PH. Pretreatment Differences in Adolescents with Increased Overjet Treated with Orthodontics and Surgery or Orthodontics alone (Masters Thesis). Chapel Hill, NC: University of North Carolina, Orthodontic Department:1989

23. Yami EA, Kuijpers-Jagtman AM, Van't Hof MA. Stability of orthodontic treatment outcome: follow-up until 10 years postretention. Am J Orthod Dentofacial Orthop. 1999;115(3):300-304.

24. Otuyemi OD, Jones SP. Long-term evaluation of treated Class II division I Malocclusions utilizing PAR index. Br J Orthod. 1995;22(2):171-178.

25. Phillips C, Broder HL, Bennett ME. Dentofacial disharmony: Motivations for Treatment. Int J Adult Orthod Orthognath Surg. 1997;12:7-15.

26. Rivera SM, Hatch JP, Dolce C et al. Patients' own reasons and patient-perceivedrecommendations for orthognathic surgery. Am J Orthod Dentofacial Orthopl. 2000;118:134-140.

27. Kiyak HA, Bell R. Psychological considerations in surgery and orthodontics. In: Proffit WR, White RP Jr, (eds). Surgical-Orthodontic Treatment. St Louis, MO: Mosby; 1992:71-95.

28. Proffit WR, Phillips C, Dann C IV. Who seeks surgical-orthodontic treatment? The characteristics of patients evaluated in the UNC Dentofacial Clinic. Int J Adult Orthod Orthogn Surg. 1990;5:153-160.

29. Bell R, Kiyak HA, Joondeph DR, et al. Perceptions of facial profile and their influence on the decision to undergo orthognathic surgery. Am J Orthod. 1985;88:323-332.

30. Mayo KH, Vig KD, Vig PS, et al. Attitude variables of dentofacial deformity patients: Demographic characteristics and associations. J Oral Maxillofac Surg. 1991;49:594-602.

31. Bell R, Kiyak HA. Psychosocial considerations in surgery and orthodontics. in Proffit WR, White RP Jr, Surgical-orthodontic treatment. St. Louis, MO: Mosby; 1991:71-81.

32. Bell R, Kiyak HA, Joondeph DR, et al. Perceptions of facial profile and their influence on the decision to undergo orthognathic surgery. Am J Orthod. 1985;88:323-332.

33. Phillips C, Griffin T, Bennett ME. Perception of facial attractiveness by patients peers, and professional. Int J Adult Orthod Orthognath Surg. 1995;10:127-135.

34. Phillips C, Bennett ME. Psychological Ramifications of Orthognathic Surgery. In Fonseca R(ed), Betts NJ, Turvey TA. (volume eds) Oral and Maxillofacial Surgery. Philadelphia, PA: W.B. Saunders Co. 2000:506-534. Vol 2.

35. Barbosa ALB, Marcantonio EM, Barbosa CEM et al. Psychological evaluation of patients scheduled for orthognathic surgery. J Nihon Univ Sch Dent 1995;35:1-9.

36. Phillips C. Patient-centered outcomes: impact on clinical practice and research. Sem Orthod. 1999;5:223-231.

37. Hugo B, Becker S, Witt E. Assesment of the combined orthodontic-surgical treatment from the patient's point of view. J Orofacial Orthop.1996;57:88-101.

38. Kiyak HA, Zeitler DL. Self-assessment of profile and body image among orthognathic surgery patients before and two years after surgery. J Oral Maxillofac Surg. 1988;46:365-371.

2. JOURNAL ARTICLE

LONG-TERM FOLLOW-UP OF CLASS II ADULTS TREATED WITH ORTHODONTIC CAMOUFLAGE: A COMPARISON WITH ORTHOGNATHIC SURGERY OUTCOMES

Abstract

Thirty-one adults who had been treated with orthodontics alone for Class II malocclusion were recalled at ≥5 years post-treatment, for evaluation of cephalometric and occlusal stability and satisfaction with treatment outcomes. These were compared to similar data for long-term outcomes in patients who had surgical correction of Class II problems. In the camouflage patients, small mean changes in skeletal landmark positions did occur long-term, but were in general much smaller than in the surgery patients. The percentage of patients with a long-term increase in overbite was almost identical in the orthodontic and surgery groups, but Class II surgery patients (who had more severe problems initially) were nearly twice as likely to have an increase in overjet long-term. The patients' perceptions of outcomes were highly positive in both the orthodontic and surgical groups. The orthodontics-only (camouflage) patients reported fewer functional or TM joint problems than the surgery patients, and had similar reports of overall satisfaction with treatment, but

patients who had their mandible advanced were significantly more positive about their dentofacial image.

Key words: PAR scores, perception indices, cephalometric measures.

INTRODUCTION AND BACKGROUND

For non-growing individuals with skeletal Class II malocclusion, there are only two possible treatment approaches: orthodontic camouflage, based on retraction of the protruding upper incisors to improve both dental occlusion and facial esthetics without correcting the underlying skeletal problem; or orthognathic surgery to reposition the mandible and/or maxilla. Skeletal Class II problems are due to mandibular deficiency and/or downward-backward rotation of the mandible caused by excessive vertical growth of the maxilla. Surgical treatment therefore consists of mandibular advancement, superior repositioning of the maxilla, or their combination. Mandibular deficiency is the problem in about two-thirds of surgical patients; one-third require maxillary surgery, either alone (15%), or in combination with mandibular surgery (20%).[1]

In one of the few published comparisons of orthodontic versus surgical correction of Class II problems in non-growing patients, our research group noted that both orthodontic and surgical patients showed similar correction of the malocclusion although the camouflage group had slightly greater overjet at one year post-treatment. The surgical patients, as expected, had a more ideal skeletal relationship, with the mandible more anteriorly positioned and the lower incisors in a more ideal position relative to basal bone.[2]

It is interesting that better data exist for long-term outcomes for orthognathic surgery than for orthodontic camouflage, although many more Class II patients are treated orthodontically. Surgery patients have been followed carefully because of concern about condylar remodeling or other skeletal changes that would produce

relapse, while dental and skeletal stability in nonsurgical patients has not been evaluated in the same systematic way. Existing data show that during the first post-surgical year, both mandibular advancement and maxillary intrusion are quite stable in the great majority of surgical Class II patients. At one year, skeletal landmarks for both groups were within 2 mm of the immediate post-surgical position in >90% of the patients in the UNC database, and similar results have been reported from other centers. Comparable stability for two-jaw surgery requires rigid internal fixation (RIF), but with it, >90% of the patients are stable during the first year.[3]

Skeletal changes occur in a surprising number of surgery patients between one and five years post-surgery, however. Long-term (five year) recall of UNC patients who had mandibular advancement showed that there was a small but statistically significant decrease in mean mandibular length (condylion-point B) from one to five years. It usually is the case that after any type of treatment, a few of the patients have most of the change, so a better perspective is gained from noting that at 5 years postsurgery, the mandible is within 2 mm of its immediate post-surgical position in 80% of the patients, while 5% have >4 mm shortening of mandiblar length (Co-Pg).[4,5] These skeletal changes are not necessarily accompanied by occlusal relapse, because compensatory movement of the teeth often occurs.

To compare this to long-term skeletal changes in adults who did not have surgery, Schubert et al recalled 33 adults for whom cephalometric radiographs were available at the end of orthodontic treatment.[6] Of these patients, 9 had refused a recommendation for surgery (two chose orthodontics instead) and 24 others received orthodontic treatment that would have produced dental but not skeletal changes, i.e.,

they had milder malocclusions and did not require surgery. Although evidence of skeletal remodeling over a five-year period was observed in these orthodontic patients, surgery patients had larger changes in most landmark positions and were more likely to have a decrease in mandibular length. Since both the magnitude and pattern of change in the non-surgical adults were different from the surgery patients, the changes beyond one year post-surgery could not be attributed just to normal adult growth. No data currently exist for long-term changes in a sample of only adult Class II patients treated with orthodontics alone.

Both occlusal and skeletal stability are important in comparing treatment outcomes. The PAR method developed in England provides a weighted measure of the occlusion that takes into account overjet, overbite, midlines, buccal occlusion and upper and lower anterior alignment.[7] Al Yami et al used PAR scores to evaluate the treatment outcomes 10 years out of treatment in 564 adolescent patients (mean age of 12.0 years $\pm$ 3.1 years at the start of treatment) with a variety of orthodontic problems.[8] Their results showed that about 2/3rds of the achieved orthodontic correction was still present 10 years after treatment. When PAR scores increased after treatment, about half of the change occurred within the first 2 years. Otuyemi et al used PAR scores to characterize the relative success of orthodontic treatment in adolescent Class II patients, and found on recall that 60% remained in the same category at 1 year and 38% at 10 years. The major factors in increasing scores were an increase in overjet and deterioration of lower anterior alignment.[9]

In evaluating treatment outcomes, it also is important to note not only the "objective" changes measured from radiographs and other records but also the

patients' perceptions. A major reason for seeking orthodontic or surgical correction of a Class II problem is to improve the quality of life, and this must be evaluated from the patients' point of view, not what their doctors measure on physical records. Most published data on perceptions of treatment are for surgical patients. Although camouflage patients do not undergo orthognathic surgery, they still have teeth extracted, their dental and facial appearance changes, jaw function is affected, and the same methods used to study surgery patients can be applied.

Essentially all long-term studies show that the great majority of surgical patients are satisfied with their result and would recommend it to others. The major sources of information are a series of studies carried out in Seattle in the 1980s by Kiyak and co-workers, and studies at UNC in the 1990s by Phillips et al.[10] In both centers, 75-80% of patients reported satisfaction with their treatment at 4-6 weeks post-surgery, and by two years nearly 90% were satisfied. Overall, patients were quite pleased with the esthetic results of treatment, and even at 2 years post-surgery many reported receiving positive comments about their appearance. In the UNC group, one-fourth of the patients at 2 years post-surgery agreed that people whom they met for the first time reacted more positively than new acquaintances had reacted prior to the patients' surgery. However, 15% said they had expected more change in their appearance than achieved, even though they reported satisfaction with the results. No data exist to compare long-term perceptions and feelings of camouflage patients versus surgical patients.

This project was based on long-term recall of adult Class II patients who had undergone orthodontic camouflage. It had three goals: (1) compare long-term skeletal

and soft tissue changes in these orthodontic patients to surgery patients; (2) evaluate long-term changes in occlusal relationships after orthodontic camouflage, and compare occlusal stability to surgery patients; and (3) evaluate patient satisfaction following camouflage treatment, using a similar survey instrument to the one previously used with surgery patients.

METHODS

1. Subjects

Despite an underlying skeletal problem, orthodontic camouflage treatment, by definition, is based on tooth movement to correct only the dental occlusion. It typically requires premolar (occasionally, other) extractions. For this study, we reviewed charts for all 135 patients in the UNC orthodontic clinic database who were listed as having orthodontic treatment between 1980 and 1995, for Class II malocclusion beginning when minimal growth would be expected (females age 17 or over, males age 19 or older). Of this group, the 74 who had treatment with upper premolar extractions (alone or in combination with lower premolar extraction) that had been completed more than 5 years previously, and had complete records available, were selected for recall. The remaining 61 patients were not included for the following reasons: 25 had treatment completed but did not have all required records, 22 had moved or transferred and could not be located, 8 had orthognathic surgery, and 6 either had compromised tx, declined previous recall or were deceased.

An extensive search (using Internet-based locating resources) was made to locate these individuals. Once the patients were located and contacted, they were very supportive of the study and willing to return to help, especially if their travel costs were reimbursed. Only two patients were unwilling to return, both of whom cited distance as a hindrance. Of the 31 (42%) successfully recalled, the average length of time since the end of orthodontic treatment was 12 years (range, 6.5 to 15.7 years). From the original sample of 74 patients, 85% were female, but 30 of the 31 recalled patients (97%) were female.

On recall, complete clinical records (impressions for study casts, intra- and extra-oral photographs, panoramic and lateral cephalometric radiographs, recall data form) were obtained, and the patients completed self-report questionnaires on perception of current problems and satisfaction (described below).

The comparison groups were Class II orthognathic surgical patients for whom long-term previously published data was available,[3,4,5] and Shubert's adult sample who either refused surgery or were treated with conventional orthodontics for a variety of problems. [6]

This study was reviewed by the committee on investigations involving human subjects and re-approved as a continuation of the project titled: Influences of Stability Following Orthognathic Surgery.

2. Analysis of Physical Records

As in previous studies at UNC, cephalometric radiographs were digitized using the UNC 139-point model.[2] A coordinate system was established, with a line

through sella rotated 6 degrees down anteriorly from the SN line as the horizontal axis, and a vertical line through sella perpendicular to it as the vertical axis. Angular measures were obtained as well as millimeter changes in landmark position as coordinate changes in this reference system (Table 1). Thus changes relative to the x,y-axis could be compared to previous studies at UNC of surgery patients and adult orthodontic patients.

In addition to descriptive statistics, analysis of covariance was used to estimate the average differences between the camouflage group and the surgically treated groups. Baseline values, age at the initiation of treatment and the duration of follow-up were included as covariates and adjusted mean change was compared among the 3 surgical groups and the Class II camouflage groups.

PAR scores were obtained from the final and recall models for the camouflage patients. Model identifiers were masked and the models were scored in a random sequence determined by a random number generator. The PAR scoring was performed by a research associate who had been trained and calibrated. A random 1/3 (32%) of the camouflage casts were reanalyzed 2 weeks later to determine intra-examiner reliability. The intraclass correlation coefficient for the unweighted PAR summary score was 0.97, confirming the reliability of the technique, and the mean difference between repeated scores was not statistically significant (paired t-test – 0.83; $p= 0.42$).

Since most of the UNC Class II surgery patients did not have long-term study models but did have intraoral photographs including lateral incisor views on which overjet could be measured, we calculated a "Photo PAR" score for 14 randomly

selected surgery patients. Using the same procedure for the camouflage patients for whom both standard photographs (excluding the lateral incisor views) and casts were available, we verified that consistent scores for all PAR components except overjet could be obtained. This had been measured clinically for the surgery patients and could be verified from their lateral incisor photographs. Repeated measurements on photos for both the camouflage and surgery groups showed that the photo scores were reproducible. This allowed at least a rough comparison of long-term changes in PAR scores in surgery and camouflage patients.

For the PAR scores, paired t-tests were used to compare the initial and final values.

3. Analysis of Patient Perceptions

At the recall appointment, 27 of the 31 orthodontic Class II patients completed the three self report questionnaires developed by Phillips and Bennett. [10] The Facial-Image (FI) scale is a 16-item questionnaire that asks the respondent to rate each facial feature from (1) have strong negative feelings to (5) have strong positive feelings. Two subscales are scored. The Dentofacial subscale is sensitive to appearance changes that can be affected by different treatment approaches. The Cosmetic Scale includes facial features that are not treatment-dependent. The second questionnaire, Problems with Occlusion and Function (PSPOF), consists of 21 statements and is rated in a 1 to 5 agree/disagree format. Two subscales are scored: Dentofacial Concerns and General Health Concerns. Satisfaction (SAT) is a 16-item instrument developed by Phillips and Bennett, on which three subscales are scored:

(Inter)Personal Outcome; Functional Outcome; and Preparation/Knowledge Satisfaction. The item content for the Preparation/Knowledge subscale was modified slightly from the context used with surgery patients. Each item was presented as a statement rated on a seven-point scale from "disagree strongly" to "agree strongly".

The camouflage patients were compared to all UNC Class II surgical patients who had completed long-term perception survey instruments. These patients were not the same groups Schubert used for the cephalometric portion of our study.[6] The long-term responses of the surgery and camouflage groups were compared using Cochran-Mantel-Haenzel row mean score test.

RESULTS

1. Cephalometric Changes in the Camouflage Patients

Mean changes for the Class II camouflage patients during treatment and on long-term recall are illustrated in Figures 1 and 2, and tabulated data are shown in Table 1. As one would expect, the treatment changes were largely retraction of the maxillary incisors. Long-term changes were quite small. Eruption of the lower incisors, leading to an average increase in overbite of 1.1 mm, was the largest mean change.

In clinical studies, a few patients usually show most of the change, so descriptive statistics based on the normal distribution can be misleading. For the camouflage patients, however, significant changes in skeletal landmarks were not observed. None of these patients showed >2 mm change in points A, B or pogonion. The cephalometric data for the camouflage patients can be summarized as showing

almost no relapse changes except for overbite. Pearson correlation coefficients showed no relationship between the length of time to recall and the changes from end of treatment to follow-up.

2. Comparison of Changes After Class II Camouflage to Other Treatment

As Table 1 shows, the differences in mean changes between the camouflage, general orthodontic and surgical groups were small. Analysis of covariance showed, however, that there was a statistically significant difference in mandibular landmark positions between the orthodontic and surgical groups. In all groups, (if it changed at all) the mandible tended to come forward and downward, but there was a significantly greater chance of movement (growth?) in the nonsurgical groups.

This is clarified by Figures 3-5, showing the percentage of patients in each group with >2 mm change in landmark positions or dimensions. Note (Figure 3) that backward movement of the chin and points A and B occurred only in the surgery groups, but forward movement of point B and Pg also occurred in all three surgical groups, and forward movement of Pg was as likely as backward movement after mandibular advancement. Forward movement of all three landmarks, and of the incisors, occurred in 15% of the general orthodontic patients but in none of the camouflage patients, who were remarkably stable. Long-term vertical changes occurred in more surgery than orthodontic patients (Figure 4), with one-fourth of the patients who had maxillary surgery showing downward movement suggestive of continued vertical growth. Incisor changes were smaller than skeletal changes. It is

interesting in examining Figure 3 and 4 that what is not there is important: no patients in the camouflage group had any long-term changes greater than 2mm.

Overjet was stable in both orthodontic groups (Figure 5), and showed a long-term increase in 10% of the 2-jaw surgery patients, 15% of the maxillary impaction group, and 20% of the mandibular advancement patients. In contrast, overbite increased in 10-15% of the patients in both the orthodontic and surgery groups. Note that the percentage with overjet changes is much greater than the percentage with changes in the ANB angle, i.e., this long-term change in the surgery groups was due more to tooth movement than skeletal change. The greater change in mandibular plane angles for the surgery patients is consistent with continued remodeling at gonion after surgery. Mandibular length, as measured from condylion to pogonion, decreased in 5% of the orthodontic patients and increased in 10%. The percentage of surgery patients with a decrease in length was greater, but nearly as many surgery patients showed an increase in mandibular length as a decrease.

3. PAR Scores

PAR scores for the Class II camouflage patients at the end of treatment and on long-term follow-up are shown in Table 2, along with the "Photo PAR" scores for the subsample of surgery patients. For the camouflage patients, there was a small but statistically significant increase in average score from final to recall ($p<.001$), but the score improved (decreased) in 4 individuals. Lower incisor irregularity increased in 55% of the group. In contrast, buccal occlusion was likely to improve: one-third of the patients (38% left, 31% right) had a lower score long-term.

Although the surgery patients had more severe skeletal problems initially (see discussion), at the end of treatment, both the weighted total scores and the amount of change from end of treatment to long-term were remarkably similar for the camouflage and surgery patients. The limited comparative data showed no indication of major differences in occlusal stability.

4. Perception Data

Results from the perception survey instruments are illustrated in Tables 3-5, which show the percentage of patients with a strongly positive response to selected items (5-7 on the 7-point scale of SAT; 4-5 on the 5-point scales of PSPOF and FI). Questions that appeared on both the camouflage and surgical versions of the forms were analyzed.

Satisfaction (SAT) (Table 3). Satisfaction scores for the camouflage patients were quite high. Perhaps the most sensitive indicator of satisfaction is reflected by willingness to undergo the same treatment again, knowing how it turned out, and 92% of the camouflage group were strongly positive. Nearly all were pleased with the change in their appearance, but only one-third agreed strongly that they could eat more easily.

Comparison with the surgery groups shows greater long-term satisfaction for the camouflage patients in almost every category, despite the positive numbers for satisfaction in the surgery groups. The only statistically significant difference, however, was that the maxillary impaction surgery group was less positive than the

other groups for the interpersonal outcomes sub-scale (Cochran-Mantel-Haenzel statistics based on table scores, $p<0.001$).

Perception of Occlusion and Function (PSPOF) (Table 4). Only a few of the camouflage patients perceived functional / pain problems. Although 15% felt that their front teeth did not fit properly, none complained that they could not chew food well. Of the 18% of the camouflage patients who reported pain in their TM joints, over half reported pain in jaw muscles as well.

These numbers also compare quite favorably to the surgery patients. Scores for occlusion and function were similar, except that the maxillary surgery patients were more likely to feel that they could not chew food well. In all three of the surgery groups, reports of TMJ-related problems and pain / discomfort were two or three times more prevalent than in the camouflage group, and the difference between the surgery and camouflage patients was statistically significant ($p<0.01$).

Facial Image Index (FI) (Table 5). The facial index can be broken into two subcategories, cosmetic image and dentofacial image. Half to two-thirds of the camouflage patients responded quite positively to the cosmetic image items (which their orthodontic treatment would not have influenced), and the frequency of positive responses were only slightly larger for the dentofacial items that would have been affected. For the mouth, half (48%) of the camouflage group gave the highest possible score of 5 on the 5-point scale, and 41% scored their teeth at 5.

On the cosmetic scale, the camouflage patients' frequency of positive items (4 or 5's on a 1-5 scale) were scored at or slightly below the level for the surgery patients. It is interesting that facial skin tone was rated most positively by the

maxillary impaction group and least positively by the camouflage group, although hard tissue support for the soft tissue facial mask would have been decreased by both types of treatment. Intermediate scores were reported by the patients who had mandibular advancement, which would increase soft tissue support and should have tightened the skin. Advancing a deficient mandible improves chin-neck contours, and the mandibular advancement patients did report higher positive feelings in this area.

For the dentofacial scale, both groups of patients who had mandibular advancement were much more positive about their chin and profile than the camouflage patients, as one would think they should have been, and this difference was statistically significant ($p<0.005$). There was no difference between the maxillary impaction and camouflage patients.

DISCUSSION

It is important to keep in mind that patients treated with orthodontic camouflage have, in general, less severe problems than those treated surgically. As Table 6 shows, the camouflage patients that we studied had less severe malocclusion initially (overjet and overbite) and smaller jaw discrepancies than Class II surgery patients. Despite the initial differences, jaw relationships and dental occlusion were similar at the end of treatment, so both types of treatment largely met their treatment objective. The amount of change produced by treatment was larger in the surgical groups, and they experienced a component of skeletal change that the orthodontic patients did not.

The greater amount of treatment change in the surgery groups probably contributed to the greater prevalence of post-treatment change. Cephalometrically, the

camouflage patients were quite stable long-term, except that 10% had an increase in overbite that could be attributed to eruption of lower incisors. Relapse in the form of >2 mm long-term increase in overjet was not observed. The percentage of patients with an increase in overbite was almost identical in the surgery and camouflage groups, but an increase in overjet occurred in 10-20% of the surgery patients. Since for them skeletal change rather than tooth movement was the major factor in reducing overjet at the time of treatment, it is surprising that the post-treatment changes were as likely to be due to tooth movement as to skeletal relapse. Perhaps this reflects greater changes in relationships between the incisors and the facial soft tissue mask in the surgery group, but the surgery patients are stable during the first post-treatment year and show changes after that, and soft tissue pressure changes would be expected to affect tooth position more quickly during the first year. Previous reports have noted that skeletal changes in surgery patients are not necessarily reflected in the occlusion, and changing dental / soft tissue relationships probably do contribute to dental compensation for skeletal change when it occurs.

It is interesting that by no means all the skeletal changes in these adult patients were in a relapse direction. Continued growth of the facial skeleton has been appreciated for years now, but it still is surprising to see how much long-term change can occur in ways consistent with continued growth, in patients who are expected to have little or no growth potential. Forward movement of facial landmarks was observed in 15% of the long-term camouflage group, and one-fourth to one-third of the surgery patients showed what appear to be growth changes, i.e., downward movement of the maxilla and/or forward movement of the mandible. Do the data

suggest that late growth is more likely in patients with the severe problems that are selected for surgery, or is this another reflection of skeletal responses to greater soft tissue changes in surgery patients? There is no way to be sure at present.

For occlusal stability, lower incisor alignment is the weak link, and retainer wear is obviously an important factor. This study showed that slightly over half the camouflage patients had a long-term increase in incisor irregularity over time, and this was true of 50% of the surgery patients as well. Al Yami et al[8] showed that the 11% of their large sample who had bonded lower retainers had better alignment at 5 and 10 years post-treatment even if their initial PAR scores were higher. Our camouflage sample had 10 of 31 patients (32%) with bonded lower retainers, and the randomly-selected surgery patients selected for evaluation of PAR scores had 3 of 14 (21%). Of the patients with bonded retainers on long-term recall, 3 had minor slippages of one or two contacts, and the rest had no change in this component of the PAR score.

The extent to which retainer wear influenced changes in PAR scores is difficult to determine, but it seems likely that this would have an effect. Two of the camouflage patients specifically stated that they only wore their retainers for a few months and then quit wearing them due to "the hassle", while on the other end of the spectrum, three patients were still wearing both retainers every night, 10 years or more out of treatment.

In evaluating patients' perceptions of treatment outcomes, it also is potentially important that the camouflage group was so overwhelmingly female. The great majority of the older Class II patients in the orthodontic clinic are female (there are

relatively more females receiving late Class II treatment than for adolescent or preadolescent treatment), and all but one of those who were successfully recalled were female. The majority of Class II surgery patients also are female, but the surgery groups were 25-30% male. Within the surgery groups, no gender difference in response to the survey instruments has been detected. We simply do not know whether this also would be true for camouflage patients.

The camouflage group overall were very satisfied with their treatment and had fewer functional and TM joint problems than any of the surgical groups. They were positive about aspects of facial appearance that was not affected by treatment as well as those that were, and in most respects as positive as the surgery patients, except that the mandibular advancement group had 20-25% more patients feeling positive about their chin. Similar findings were reported by Kiyak et al in the 1980s, who noted that even though Class II camouflage patients were aware of differences in chin projection, the great majority were pleased with the outcome of treatment.[11]

From our perspective, these data show that properly-selected patients for orthodontic camouflage treatment are as or more likely to be satisfied with the outcome of treatment as those who receive surgery. Proper selection of patients, of course, is neither simple nor easy. When alternative treatment approaches are possible, the ratio of benefit to risk must be considered for each procedure. For orthodontic camouflage versus surgery, the important decision is whether the greater improvement in dentofacial image that is possible with surgery would be worth the increased cost and risk. The risks of surgery obviously can be much greater than those of a non-surgical approach. The most common surgical risk is decreased sensation of

the lips, whereas with camouflage patients the greatest risk appears to be resorption of maxillary incisor roots as they are retracted and torqued against the lingual cortical plate. The ideal patient for camouflage should have reasonably good facial esthetics initially, with overjet created more by maxillary incisor protrusion than mandibular retrusion. The more severe the mandibular deficiency and the greater the overjet, the greater the need for surgery to obtain satisfactory clinical correction.

How the patient perceives the severity of their problem definitely is a factor in the decision to proceed with surgery versus camouflage treatment. There is good evidence that, however a patient would appear to an outside observer, the more that individual perceives herself (or himself) as normal, the more likely (s)he is to choose orthodontics alone and to be satisfied with the outcome. Conversely, patients who perceive themselves as outside the normal range are more likely to prefer surgery and to be dissatisfied with tooth movement alone.[11] Problem severity cannot be evaluated just from cephalometric radiographs, dental casts and other physical records.

In the modern world, when alternative treatments are available, the doctor's role is to provide the information a patient needs to make an informed decision. Use of computer image predictions of outcomes can help patients visualize the effect of surgery versus camouflage, and existing data now show that the benefits of using this approach with patients outweigh the risk of arousing unrealistic expectations.[12,13] This is an excellent way to involve the patient in the decision as to the preferred mode of treatment and to evaluate what the patient perceives—an essential part of proper selection of patients for camouflage or surgery.

Acknowledgments

This project was supported in part by NIH grant DE-05215 from the National Institute of Dental and Craniofacial Research. We thank Ms. Lyna Rogers for assistance with PAR scores, Ms. Debora Price for help with data acquisition and analysis, and Drs. George Blakey and L'Tanya Bailey for helpful comments.

REFERENCES FOR JOURNAL ARTICLE

1. Proffit WR, White RP, Sarver DM. Contemporary treatment of dentofacial deformity. St. Louis, Mosby, 2002.
2. Proffit WR, Phillips C, Douvartzidis N. A comparison of outcomes of orthodontic and surgical-orthodontic treatment of Class II malocclusion in adults. Am J Orthod 1992; 101:556-65.
3. Proffit WR, Turvey TA, Philips C. Orthognathic surgery: a hierarchy of stability. Int J Adult Orthod Orthognath Surg 1996; 11:191-204.
4. Simmons KE, Turvey TA, Phillips C, Proffit WR. Surgical-orthodontic correction of mandibular deficiency: five year follow-up. Int J Adult Orthod Orthogn Surg 1992; 7:67-80.
5. Miguel JA, Turvey TA, Phillips C, Proffit WR. Long-term stability of two-jaw surgery for treatment of mandibular deficiency and vertical maxillary excess. Int J Adult Orthod Orthogn Surg 1995; 10:235-245.
6. Schubert P, Bailey LJ, White RP, Proffit WR. Long-term cephalometric changes in untreated adults compared to those treated with orthognathic surgery. Int J Adult Orthod Orthognath Surg 1999;14:91-99.
7. Richmond S, Shaw WC, Roberts CT, Andrews M. The PAR index (Peer Assessment Rating): methods to determine outcome of orthodontic treatment in terms of improvement and standards. Eur J Orthod 1992;14:180-7.

8. Al Yami EA, Kuijpers-Jagtman AM, Van't Hof MA. Stability of orthodontic treatment outcome: follow-up until 10 years postretention. Am J Orthod Dentofacial Orthop 1999;115:300-304.

9. Otuyemi OD, Jones SP. Long-term evaluation of treated Class II division 1 malocclusions utilizing the PAR index. Brit J Orthod 1995; 22:171-178.

10. Phillips C, Bennett ME. Psychological ramifications of orthognathic surgery. In Fonseca R(ed), Betts NJ, Turvey TA (volume ed). Oral and Maxillofacial Surgery Vol 2. Philadelphia, W.B. Saunders Co. 2000:506-534.

11. Bell R, Kiyak HA, Joondeph DR et al. Perceptions of facial profile and their influence on the decision to undergo orthognathic surgery. Am J Orthod 1985; 88:323-332.

12. Phillips C, Hill BJ, Cannac C. The influence of video imaging on patients' perceptions and expectations. Angle Orthod 1995; 65:263-270.

13. Kiyak HA, Zeitler DL. Self-assessment of profile and body image among orthognathic surgery patients before and two years after surgery. J Oral Maxillofac Surg 1988; 46:365-371.

Table 1: Comparison of Mean Cephalometric Changes

Table 1	Comparison of mean changes of camouflage adults to orthodontic adults and surgical patients. (Post-Treatment to long-term recall **)									
	Orthodontics only				Surgery					
	Adult Cl II Camouflage		* Adult General Tx		*Maxillary Impaction		*Mand Advancement		*Two-Jaw Surgery	
N	31		33		49		35		34	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Vertical changes (mm)										
Point A	0.19	0.86	0.02	0.55	0.73	2.03	0.12	1.48	0.74	1.61
ANS	0.12	0.46	-0.10	0.61	0.64	1.68	0.08	0.74	0.37	1.01
PNS	0.05	0.33	0.18	0.53	0.60	1.13	0.12	1.48	0.39	0.76
Point B	-0.03	0.8	0.35	1.03	0.81	2.50	-0.74	2.51	0.91	2.76
Me	0.09	0.7	0.50	0.97	1.39	1.45	0.24	1.32	0.96	1.25
Pg	0.21	0.78	0.42	1.07	0.88	2.29	-0.03	1.71	1.17	1.34
Go	0.11	1.09	0.70	1.42	-0.98	3.03	-0.42	3.17	0.06	2.48
Co	-0.15	1.22	0.29	0.93	-0.02	1.64	-0.05	1.86	-0.42	1.76
MxInc	0.50	0.57	0.37	0.94	1.06	1.22	0.28	1.04	0.79	0.94
MxMol	0.11	0.94	0.17	0.91	1.23	1.13	0.94	1.34	0.93	1.32
MdInc	-0.59	0.84	-0.14	1.16	0.55	1.50	-0.45	1.39	0.28	1.58
MdMol	0.14	1.09	0.14	0.97	0.59	1.36	0.42	1.47	0.49	1.37
Horizontal changes (mm)										
ANS	0.03	0.46	0.47	0.95	-0.14	2.05	0.07	1.11	0.40	1.56
PNS	-0.01	0.47	0.23	0.82	-0.97	2.97	0.32	0.96	-1.57	1.97
Point A	0.05	0.79	0.48	0.80	-0.12	1.19	-0.10	0.90	-0.04	0.92
Point B	-0.04	0.85	0.46	1.23	-0.67	1.71	-0.12	1.88	-1.11	1.93
Pg	-0.03	0.96	0.62	1.24	-0.89	2.09	-0.21	2.07	-1.48	2.18
Go	0.01	1.08	0.27	1.06	-1.69	2.28	-0.45	2.68	-0.56	2.58
Me	-0.03	1.2	0.54	1.25	-1.45	2.52	-0.21	2.30	-1.72	2.38
Co	-0.17	1.22	-0.06	0.89	0.47	2.04	0.45	1.39	0.99	2.41
MxInc	0.09	0.86	0.50	1.21	-0.08	1.32	0.05	1.33	0.49	1.36
MdInc	-0.23	0.91	0.26	1.23	-0.47	1.75	-0.51	1.60	-1.10	1.36
MxMol	0.09	1.11	0.91	1.82	0.20	2.46	0.71	2.35	-0.47	2.15
MdMol	-0.01	0.94	0.67	1.68	-0.47	2.48	0.06	2.42	-0.73	1.76
Dimensional changes										
Overjet (mm)	0.56	0.5	0.17	0.69	0.33	1.15	0.26	1.03	0.41	1.32
Overbite (mm)	1.10	0.67	0.54	1.07	0.50	1.29	1.05	1.29	0.51	1.44
SNA (deg)	-0.05	1.02	0.10	0.68	-0.01	1.24	0.12	1.07	0.04	0.96
SNB (deg)	-0.11	0.77	0.19	0.82	-0.31	0.92	-0.22	1.00	-0.51	0.99
ANB (deg)	0.04	1.10	0.09	0.58	0.25	1.34	0.42	0.94	0.39	1.12
PalPl (deg)	0.12	0.69	-0.28	0.85	0.01	2.20	0.02	1.16	-0.08	1.46
MdPl (deg)	0.08	1.35	-0.31	1.00	1.41	1.95	0.27	2.10	1.23	1.65
TFH (mm)	0.15	0.76	0.56	1.01	1.66	1.63	0.35	1.41	1.27	1.32
Ar-B (mm)	-0.13	0.77	0.62	1.33	0.03	1.73	-1.06	1.55	-0.16	1.68
Co-B (mm)	0.15	0.85	0.47	0.98	-0.14	1.84	-0.89	1.95	-0.31	2.08
Co-Go (mm)	0.23	1.19	0.44	1.34	-1.11	2.05	-0.41	3.42	0.37	3.03
Co-Pg (mm)	0.31	0.86	0.59	0.91	-0.05	2.02	-0.36	2.06	-0.13	1.51

Vertical changes: Negative value indicates superior movement; positive value indicates inferior movement.

Horizontal changes: Negative value indicates posterior movement; positive value indicates anterior movement.

Dimensional changes: Negative value indicates a decrease; a positive vlaue indicates an increase.

* Data obtained from Schubert et al. (reference 6)

** Mean Follow-up length in years: Camouflage 12.0 ± 2.8; Ortho 6.9 ± 3.7; Mx Imp 6.8 + 2.3; Md Adv 5.9 +1.1; Two-Jaw 6.5 ± 2.1.

** Post-treatment for surgical patients begins at 1yr post-surgery

Table 2: Comparison of Mean PAR Scores

Table 2	Comparison of Mean PAR Scores of Camouflage Adults to Surgical Patients							
	Class II Camouflage				Class II Surgery			
	End Tx	SD	Long-term	SD	End Tx	SD	Long-term	SD
Weighted Total:								
English	6.14	4.39	9.55	6.10	7.00	4.96	9.43	6.32
American	8.55	5.21	10.97	6.64	8.50	5.24	9.29	6.12
English weighted Components:								
UA	0.27	0.53	0.80	1.00	0.50	0.52	0.79	0.70
LA	0.48	0.69	1.30	1.60	0.71	1.07	1.70	1.40
RB	1.48	0.95	1.45	0.95	1.40	0.90	0.90	0.90
LB	1.62	0.82	1.48	1.06	1.00	0.90	0.90	0.90
OJ	1.86	2.82	3.31	4.12	2.14	2.98	2.57	3.08
OB	0.30	0.90	0.83	1.14	0.71	0.99	1.10	1.30
ML	0.10	0.70	0.40	1.20	0.57	1.45	1.00	2.00
American weighted Components:								
UA	0.27	0.53	0.80	1.00	0.50	0.52	0.79	0.70
LA (not scored)								
RB	2.97	1.90	2.90	1.90	2.71	1.86	1.86	1.83
LB	3.24	1.64	2.97	2.11	2.00	1.75	1.71	1.90
OJ	1.55	2.35	2.76	3.43	1.79	2.49	2.14	2.57
OB	0.40	1.30	1.24	1.70	1.07	1.49	1.71	1.94
ML	0.10	0.56	0.31	0.93	0.43	1.09	1.07	1.49

UA = Upper Arch, RB = Right Buccal OJ = Overjet ML = Midline
LA = Lower Arch LB = Left Buccal OB = Overbite

PAR Weighting	English	American
UA	x1	x1
LA	x1	not scored
RB	x1	x2
LB	x1	x2
OJ	x6	x5
OB	x2	x3
ML	x4	x3

Table 3 Satisfaction (SAT) Index

Table 3	Satisfaction (SAT) Index											
	Percent at extreme (strongly positive)											
	Orthodontics only						Surgery					
	Adult Cl II Camouflage			Maxillary Impaction			Mand Advancement			Two-Jaw Surgery		
n	27			24			103			66		
Selected Questionnaire items												
Interpersonal outcomes												
Receive positive comments since treatment	69			46			52			67		
Pleased with change in appearance	85			63			77			83		
Treatment change was exactly what I expected	88			46			63			46		
People react more positively at initial meeting	50			29			30			33		
Delighted how much better I look	88			42			69			69		
Like what I see in the mirror	88			50			76			75		
Functional outcomes												
Eating is much easier	35			46			57			53		
Can Chew Better	35			54			62			50		
Other												
Recommend treatment to others	100			75			87			83		
Undergo treatment again	92			79			85			76		
Treatment was a positive experience	100			84			87			88		
Subscales Scores	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
Interpersonal outcomes	5.8	0.9	6.0	4.5	1.4	4.3	5.2	1.1	5.2	5.3	1.1	5.4
Functional outcomes	4.6	1.3	4.3	4.8	2.0	5.0	5.2	1.5	5.2	5.1	1.4	5.0

Table 4 Perception of Occlusion and Function (PSPOF) Index

Table 4	Perception of Occlusion and Function (PSPOF) Index											
	Percent at extreme (strongly positive)											
	Orthodontics only			Surgery								
	Adult Cl II Camouflage			Maxillary Impaction			Mand Advancement			Two-Jaw Surgery		
n	28			24			106			70		
Questionnaire Item												
Occlusion and Function												
Front teeth stick out too much	7			21			8			6		
Have a deep bite	15			8			10			6		
Have an open bite	11			25			21			21		
Front teeth do not fit properly	15			33			13			13		
Can not chew properly	15			13			11			10		
Posterior open bite	11			9			12			14		
Back teeth do not fit properly	7			9			17			13		
Can not chew food well	0			25			7			22		
TMJ Related problems												
Jaw hurts when mouth open wide	4			21			28			27		
Jaw moves sideways when opening	4			13			8			9		
Jaw makes grating/grinding noise	4			17			17			9		
Can not open mouth wide	11			21			19			19		
Jaw pops/clicks	14			25			28			19		
Pain, Discomfort or Soreness												
Pain in temples	4			13			8			4		
Pain in jaw joints	18			46			27			34		
Pain in jaw muscles	11			38			23			25		
Pain in ears	7			21			11			10		
Subscales Scores	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
TMJ related problems	1.5	0.9	1.0	2.1	0.8	1.8	2.1	0.9	2.0	2.0	0.8	1.9
Function/occlusion problems	1.9	0.7	1.7	2.0	0.9	1.8	1.8	0.6	1.7	1.8	0.8	1.6

Table 5 Facial Image (FI) Index

Table 5	Facial Image (FI) Index			
	Percent at extreme (strong positive feelings)			
	Orthodontics only	Surgery		
	Adult Cl II Camouflage	Maxillary Impaction	Mand Advancement	Two-Jaw Surgery
n	28	20	82	55
Questionnaire item				
Cosmetic Image				
Hair	70	85	83	78
Ears	59	65	78	75
Forehead	57	60	78	65
Eyes	74	85	87	78
Nose	52	58	66	64
Lips	70	65	76	60
Facial Complexion	59	70	66	64
Neck	48	55	71	69
Eyebrows	52	75	79	65
Cheeks/Cheekbones	70	65	86	65
Facial skin tone	56	80	71	65
Dentofacial Image				
Mouth	76	60	79	62
Teeth	74	65	82	67
Chin	48	45	76	57
Profile	52	55	73	64
Smile	74	52	69	63

Subscales Scores	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
Total Facial Image scale	3.8	0.7	3.8	3.8	0.7	3.9	4.1	0.6	4.0	3.8	0.7	3.9
Dentofacial Image	3.9	0.8	4.0	3.5	1.0	3.7	4.1	0.6	4.0	3.8	0.8	3.8
Cosmetic Image	3.8	0.7	3.7	4.0	0.6	4.0	4.1	0.7	4.0	3.9	0.8	3.9

Table 6. Comparison of Mean Initial Cephalometric Measures.

Table 6	Comparison of mean initial cephalometric measures Camouflage Adults* and Surgical Patients.**							
	Adult Cl II Camouflage		Maxillary Impaction		Mand Advancement		Two-Jaw Surgery	
% Female	97		84		77		97	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Measurements								
Overjet (mm)	4.31	1.79	6.03	3.44	7.90	2.44	8.97	3.27
Overbite (mm)	3.13	1.30	0.25	3.22	9.34	2.80	2.87	2.66
SNA (deg)	82.64	4.07	78.87	3.59	80.91	3.39	79.25	3.86
SNB (deg)	77.14	3.78	73.02	4.22	74.34	3.73	71.81	4.50
ANB (deg)	5.50	1.90	3.92	2.55	6.57	2.39	7.45	2.60
MdPl-SN (deg)	33.92	7.06	44.54	6.78	34.2	8.92	43.66	8.39
MxInc-SN (deg)	105.11	9.32	102.02	8.30	103.97	7.84	100.11	8.43
MdInc to MP(deg)	103.48	8.02	96.18	6.47	100.35	7.83	94.20	8.23
* initial cephalmetric measures for camouflage patients * pre-surgical cephalmetric measures for surgery patients								

Figure 1. Superimposition of camouflage patients' mean treatment changes.

Figure 2. Superimposition of camouflage patients' mean post-treatment changes

Figure 3. Vertical Changes among Surgical and Non-Surgical Patients.

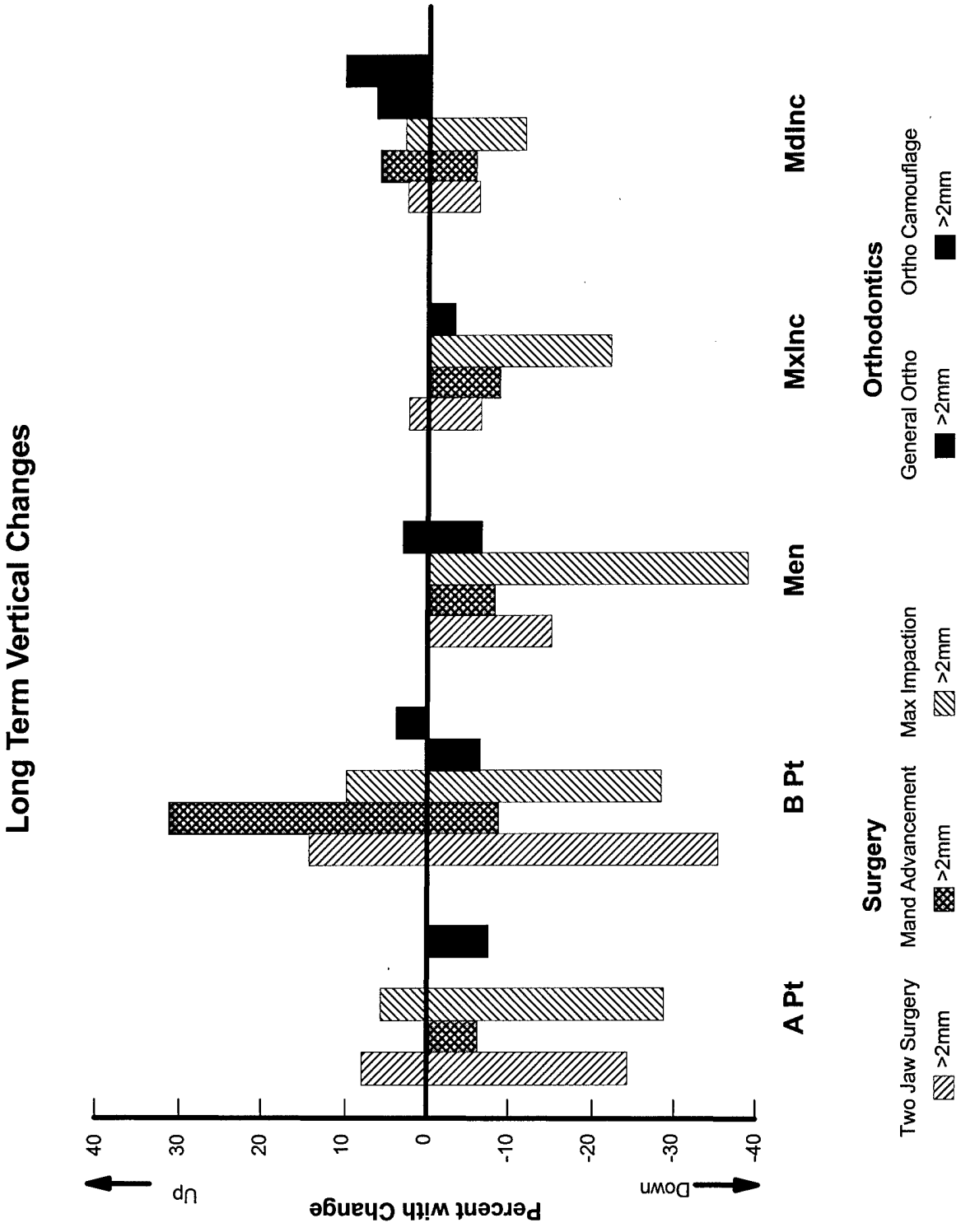


Figure 4. Horizontal Changes among Surgical and Non-Surgical Patients..

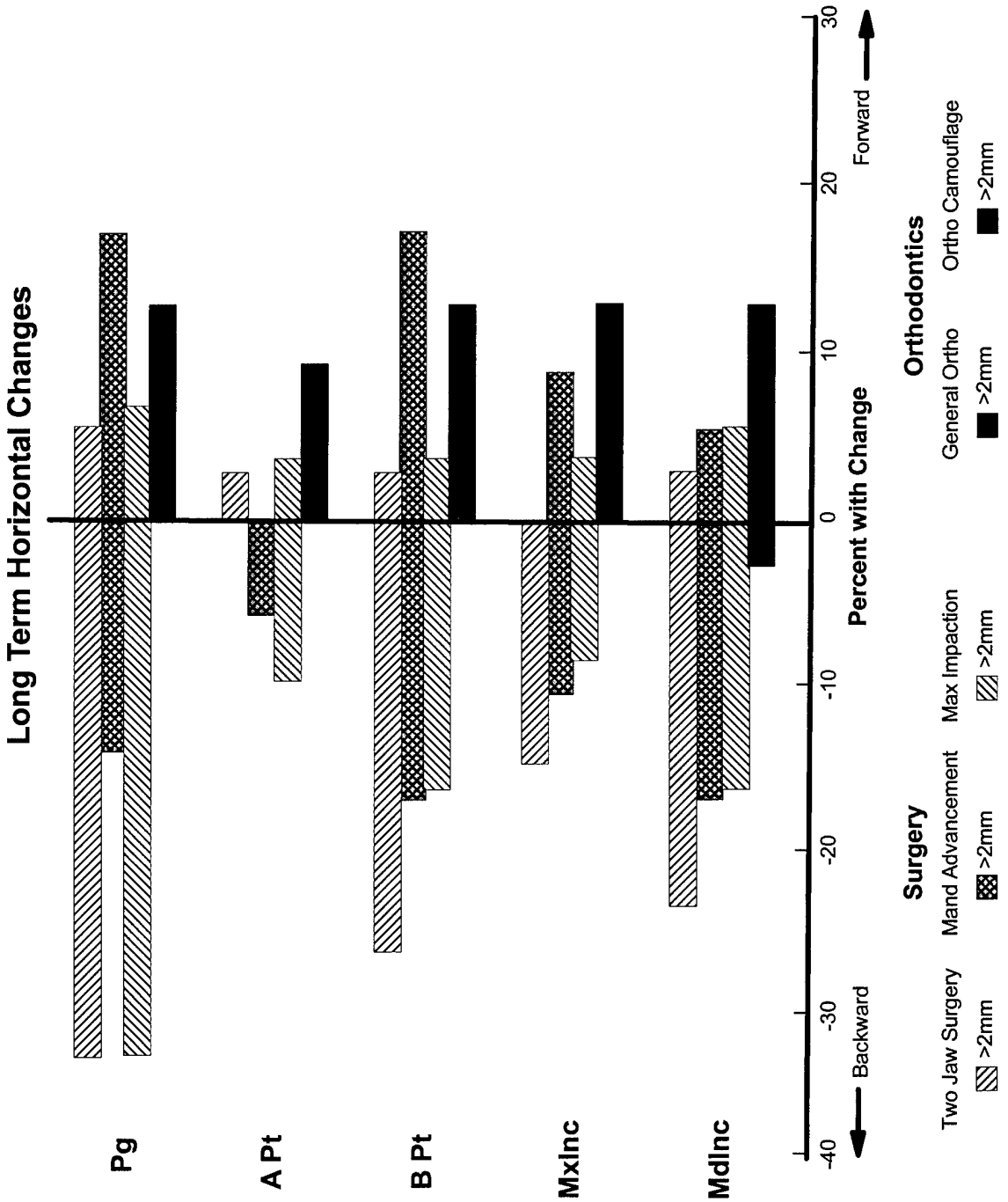
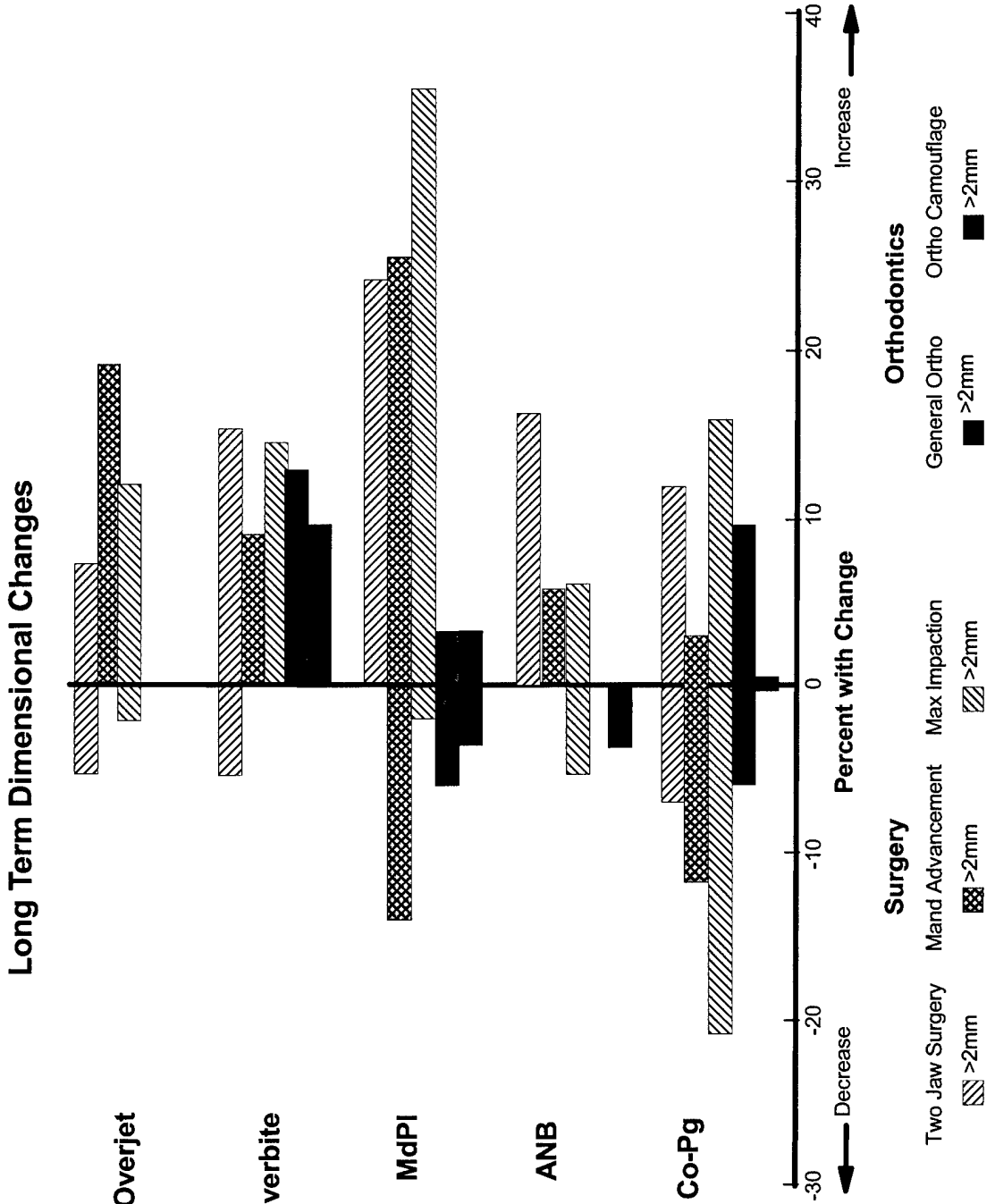


Figure 5. Dimensional Changes among Surgical and Non-Surgical Patients.



3. APPENDICES (additional data not contained within the Journal article)

Sample Selection.

The specific criteria needed to be included as a camouflage patient in the study sample:

A. Age: In order to limit growth as a factor in previous treatment, patients were selected based on the following categories: Females > 17 years old at the start of treatment and Males >19 years old at the start of treatment.

B. Patients were identified as having a class II skeletal or dental malocclusion. Treated with extractions (ideally premolars, but not exclusively) as a camouflage treatment pattern to mask an underlying problem.

C. Patients were at least 5 years out of treatment and must have had all the appropriate records taken at the initiation of treatment, at the completion of treatment. These records included: panorex, lateral cephalogram, study models and clinical photos and appropriate charting).

Recall Efforts.

Patients were contacted by telephone and scheduled a routine 5 or more year recall appointment in the Orthodontic clinic at UNC. The following data was collected: Impressions were taken for study models, which were used to look at the irregularity index (PAR Score) as an indicator of relapse, charting was completed on the UNC orthodontic yellow recall form (Appendix 1and 2), intra and extra-oral clinical digital

photographs, a panograph and lateral cephalogram were completed and finally three perception questionnaires and one data form were completed (Appendix 3-7). The first questionnaire (Appendix 3) updated their personal data and asked specific questions about their treatment options at the time of their case presentation. Additionally, they were asked if surgery was ever offered as a treatment alternative. The next 3 surveys (FI, PSPOF and SAT) (Appendix 4-7) were the same 3 surveys used with the orthognathic surgical patients. These surveys were used to compare our patients to patients having undergone surgery for Class II correction.

Facial Image (FI): This 16- item instrument evaluated the patients' level of post-treatment dental and cosmetic changes and whether overall esthetic changes are viewed as positive or negative.

Post-surgical perception of occlusion and function (PSPOF): This 17-item instrument assessed the patients' perception of their dental occlusion and jaw function post orthodontics or surgery (if used on surgical patients).

Satisfaction (SAT): This 25-item instrument evaluated the patients' level of post treatment contentment with the changes, and their perception of how well they were prepared, and if overall the experience was positive or negative.

The specific measurements included in the English PAR weighting system

Par Components are listed in Appendix 8.

Descriptive Statistics for camouflage patients' final to recall models.

See Appendix 9

PAR Score Reliability of camouflage patients' models.

19 (32%) of the casts were randomly selected (from final and recall casts) by the primary investigator (cam) and compared to the score received when first examined using the PAR method. These casts were masked of identification information and distributed to the examiners. At least 2 weeks elapsed between measurements of a given cast. The intra-examiner reliability is shown in Appendix 10. The individual PAR score components for these repeated models are listed in Appendix 11 for ease of comparison to the first measurement. Using the un-weighted PAR scores to assess reliability, the overall raw percentage agreement ranged from 79% to 100% for the 7 score components that make up a PAR score Appendix 12. Overjet and midline were identical indicating excellent reliability. The percent agreement and weighted Kappa coefficient ranged from 0.8 to 1.0, with anything above 0.45 as acceptable and above 0.75 as ideal.

The interclass correlation coefficient for the un-weighted PAR summary score was 0.97, confirming the reliability of the PAR scoring technique used by the examiners. The difference in the un-weighted sum showed a mean difference of –0.15, thus there is only a small difference between the means, which is the desired outcome. The mean difference between repeated scores was not statistically significant (Paired t-test: -0.83; P value 0.42). This high P value showed there is no difference between the means and again gave the desired outcome of no difference between the repeated scorings of the camouflage patient's models.

Photo PAR Score Reliability of camouflage patients

In order to later quantify the surgical patients photos (since they had no models), a method was developed to verify that a photo PAR scores did in fact give a similar score to PAR scores done on the camouflage patient's models. Once this Photo PAR was verified, it could be used on the surgery patients who only had photographs. All 26 sets of recall clinical photos of the camouflage patients were re-scored by the same examiner at least 2 weeks after the first scoring. The photos were loaded into Dolphin Imaging and scored while looking at the routine clinical layout of 3 extraoral photos (Serious, smile and profile) and the 5 intraoral pictures (frontal intraoral, right and left buccal shot and a maxillary and mandibular occlusal picture). Due to the nature of buccal photographs, only the first molars were evaluated and OJ on these photographs was not evaluated. The intra-examiner reliability is shown in Appendix 13. The overall raw percentage agreement ranged from 85% to 96% for the 6 individual un-weighted components that make up a PAR score. The weighted Kappa coefficient ranged from 0.88 to 0.95, indicating excellent reliability (Appendix 14). Looking at the un-weighted sum of all the individual components, the interclass correlation coefficient was 0.97. This high level of correlation showed that our repeat photo PAR scores were very consistent for the camouflage patients. Now it had to be determined if this was an effective method for PAR scoring our Class II surgical patients who only had pictures.

PAR Score Reliability of Surgery patients using Photo PAR

The surgical patients had their final photos and recall photos (5 or more years), PAR scored on 2 occasions. The reliability ranged from 0.59 – 1.0. Additionally the un-weighted sums for both the final pictures and the recall pictures showed the Paired t-test values to be not significant and thus no difference in reliability between the 2 scorings of the Picture PAR scores for the surgical patients. See Appendix 15.

Par Score Reliability of camouflage patients' models to photo PAR scores.

Now that the reliability was confirmed for the camouflage patients model to models, and pictures to pictures and the surgical patients pictures to pictures, it was time to compare the camouflage patients' models to pictures, so that any changes in the surgical patients' picture PAR scores could be used to see long term changes. Appendix 16 shows the scores for the camouflage patients on both the models and new photo PAR scores. Since OJ could not be easily measured on the photos, this component was removed from the original PAR scores on the models to have a more comparable EWS between the photos and the models.

Since the camouflage recall patients had both models and pictures, this photo PAR score was tested for accuracy. The PAR score components for the final model camouflage versus the photo PAR camouflage are listed in Appendix 17. (Note: this table does not include overjet). The reliability of the buccal segments is difficult to interpret on the photos and tended to be interpreted as a good buccal occlusion when in fact the models showed more accurately that certain segments did not interdigitate as well on the models.

Although the photo reliability was good when comparing pictures to pictures, and the model PAR was reliable when comparing models to models, the model to photo scores showed an obvious bias. Appendix 17 shows that the left and right buccal segments were not reliable, and OJ could not be scored on our camouflage patients since they had no OJ pictures. Overall, this Photo PAR score for the surgical patients would be useful only to give an indication of areas of change over time, but not a precise measurement.

Dental Occlusion Changes over time for camouflage patients.

Looking at the English weighted Total PAR scores for the final to recall data, Appendix 18 gives the Univariate Procedure, which shows the change in the total score (EWS) ranged from +15 (indicating relapse) to –3 (improvement). Since OJ is weighted with a factor of 6, this was a major contributor to a negative change. Appendix 21 shows the camouflage group to have a statistically significant difference over time in the following components: UA, LA, OJ, OB and EWS.

Dental Occlusion over time for Surgery patients

The actual PAR score components for the final pictures and recall pictures for the surgery patients are listed in Appendix 19. Additionally, Appendix 20 gives the descriptive statistics for the English weighted score for the Final and Recall pictures for the surgical patients. Note that unlike the camouflage patients for whom no overjet photos were taken, the surgical patients had overjet pictures. This allowed OJ to be scored using <4mm as a score of 1 and >4mm a score of 0.

Looking at the individual PAR components on the surgery patients from the time of final pictures to recall, only 1 of the 8 components (lower arch alignment p=0.028)

showed a statistical significant change over time. (See Appendix 21). It is interesting to see that the PAR component of LA is the same one that changed over time with the camouflage group. EWS was close to being significant in this group (0.07), and in the camouflage group it was significant.

Looking at the English weighted Total Photo PAR scores for the final to recall data the Appendix 22 gives the Univariate Procedure. The change in the total score (EWS) ranged from +9 (indicating relapse) to –2 (improvement). Since OJ was evaluated in the previously described modified form, when multiplied by the EWS factor of 6, it could only be multiplied by 0 if <4mm of OJ and 1 if >1 mm of OJ.

Appendix 1. Retention Form (Front)

UNIVERSITY OF NORTH CAROLINA
SCHOOL OF DENTISTRY
POSTDOCTORAL ORTHODONTIC CLINIC
RETENTION EXAMINATION

PATIENT NAME: _____

RECORD NO: _____

☐ One Year ☐ Two Year ☐ Five Year ☐ Ten Year ☐ Other (specify) ___

Retainer in Use: ☐ No ☐ Mx Fixed ☐ Mx Removable
☐ Md Fixed ☐ Md Removable

INTRAORAL EXAMINATION:

Root Resorption: ☐ No ☐ Localized ☐ Generalized
Extent: ☐ Mild ☐ Moderate ☐ Severe

Maxillary Alignment: ☐ Normal ☐ Spaced ☐ Crowded
☐ < 3mm ☐ 3-6mm ☐ > 6mm

Mandibular Alignment: ☐ Normal ☐ Spaced ☐ Crowded
☐ < 3mm ☐ 3-6mm ☐ > 6mm

Midlines: ☐ Coincident ☐ Deviate < 3mm ☐ Deviate 3mm or more

Transverse: ☐ Correct ☐ X-Bite Tendency ☐ X-Bite

Mandibular Shift: ☐ No ___ mm AP ___ mm Trans. ___ mm Vertical

AP Relationship: ☐ Class I
If not Class I, Molar: ☐ Class II ☐ Class III ☐ Subdivision
Canine: ☐ Class II ☐ Class III ☐ Subdivision

Overjet: ____ mm (- indicates reverse overjet)

Overbite: ____ mm (- indicates openbite)

Posterior Open Bite: ☐ No ☐ Yes

Appendix 2. Retention Form (Back side)

RETENTION EXAMINATION **Page 2**

MASTICATORY AND FUNCTIONAL EXAM:

Maximum Voluntary Opening: _____ mm
Deviation: [ ] No [ ] Yes
Pain: [ ] No [ ] Yes

Maximum Forced Opening: _____ mm
Deviation: [ ] No [ ] Yes
Pain: [ ] No [ ] Yes

Sounds: [ ] No [ ] Click [ ] Crepitus

Tenderness on Palpation: [ ] No [ ] Yes
If Yes, where? [ ] Temp. [ ] Mass. [ ] Lat. Lig. of TMJ

History: [ ] No [ ] Yes
If Yes, [ ] Pain [ ] Dysfunction (Specify) _____

Habits: [ ] No [ ] Past [ ] Present
If Yes, [ ] Lip [ ] Thumb [ ] Other (Specify) _____

SIGNATURES: _____ Date: ___/___/___
Print Name of Attending

_____ _____ _____
Print Name of Examining Resident | Resident No. | Signature of Examining Resident

GORTH:FORM # **Revised 3/92**

Appendix 3. Data Form

UNC Dentistry
Department of Orthodontics
Campus Box 7450,
Chapel Hill, NC 27599-7450
(919) 966 4428

On behalf of the Orthodontic Department, we want to thank you for helping us with our continuing research project to help the science of Orthodontics. We know your time is valuable and appreciate your return to the school to help us take records, which are at least 5 years past the completion of your treatment. Your records are part of a long term study to see the effects of treatment, and help improve treatment for the future.

In order to keep our data current please could you provide us with an updated address and phone number.

Name_____
Home
Address_____
City _____ State_____ Home phone_____

Work
Address_____
City_____State _____Work phone _____

Someone who will always know where you can be reached. Name_____
Address_____
City _____State_____Phone_____

We are very interested in knowing what your expectations were prior to treatment and how you felt at the conclusion of treatment. We are asking you to please complete the attached surveys and the question below. (This should take less than 10 minutes)

Question #1
Thinking back on when you came to the Orthodontic Department for your treatment plan presentation (the appointment after all your records were collected), do you remember any options given to you besides the plan you were treated with?

Yes/NO and describe briefly.

_____

_____

_____

Do you remember ever being given an option for surgery to move either of you jaws?
Yes/NO
If yes please describe the type of surgery and what it was to accomplish_____

_____

_____

_____

Appendix 4. Satisfaction Form

UNIVERSITY OF NORTH CAROLINA
SCHOOL OF DENTISTRY
PATIENT PERCEPTION
SAT - Orthodontics Only

ID NUMBER: ☐☐☐☐
PATIENT INITIALS: ☐☐☐
DATE: ☐☐ / ☐☐ / ☐☐☐☐

Study: ● Ortho

Visit: ○ End of Ortho ○ ☐☐ Yrs Post-Treatment

Instructions: For each of the questions below FILL IN THE CIRCLE COMPLETELY which best describes the feelings you have TODAY about the orthodontic treatment you have had.

	Strongly Disagree			Neutral			Strongly Agree
a. Eating is so much easier for me now that my orthodontic treatment is over.	○	○	○	○	○	○	○
b. Even people who don't know me well have made positive comments about my appearance since my orthodontic treatment has been completed.	○	○	○	○	○	○	○
c. I really thought that orthodontic treatment would improve my appearance more than it did.	○	○	○	○	○	○	○
d. If I had to make the decision again, I would undergo the same orthodontic treatment.	○	○	○	○	○	○	○
e. I can chew much better now that I have had orthodontic treatment.	○	○	○	○	○	○	○
f. The way that orthodontic treatment changed my appearance is exactly what I expected.	○	○	○	○	○	○	○
g. I would recommend orthodontic treatment to others.	○	○	○	○	○	○	○
h. Now that my orthodontic treatment is over, my teeth really fit together well.	○	○	○	○	○	○	○
i. When I look in the mirror, I am really pleased with the way that orthodontic treatment has changed my appearance.	○	○	○	○	○	○	○
j. I am unhappy with the results of my orthodontic treatment.	○	○	○	○	○	○	○
k. I can bite into foods better than I could before orthodontic treatment.	○	○	○	○	○	○	○
l. When I meet people for the first time, they react more positively to me than they did before I had my orthodontic treatment.	○	○	○	○	○	○	○
m. I would recommend orthodontic treatment to anyone who has trouble eating or chewing because of a bad bite.	○	○	○	○	○	○	○
n. Since my orthodontic treatment, I truly like what I see when I look in the mirror.	○	○	○	○	○	○	○
o. In general, my orthodontic treatment experience was a negative one.	○	○	○	○	○	○	○
p. I have been delighted at how much better I look since my orthodontic treatment.	○	○	○	○	○	○	○

17121

Appendix 5. PSPOF

UNIVERSITY OF NORTH CAROLINA
SCHOOL OF DENTISTRY
PATIENT PERCEPTION
PSPOF - Orthodontics Only Recall

ID NUMBER: ☐☐☐☐
PATIENT INITIALS: ☐☐☐
DATE: ☐☐ / ☐☐ / ☐☐☐☐

Study: ● Ortho

Visit: ○ End of Ortho ○ ☐☐ Yrs Post-Treatment

Instructions: We are very interested in your thoughts and feelings about your teeth and mouth. Please read each statement carefully and FILL IN THE CIRCLE COMPLETELY that best describes your degree of agreement with the statement.

	Strongly Disagree				Strongly Agree
a. When I bite down, my lower teeth stick out too much.	○	○	○	○	○
b. When I bite down, my upper teeth stick out too much.	○	○	○	○	○
c. I have a nice smile.	○	○	○	○	○
d. When I bite down, my upper front teeth cover too much of my lower teeth.	○	○	○	○	○
e. When I bite down, my upper and lower front teeth don't touch.	○	○	○	○	○
f. My upper and lower front teeth fit together like they should (come together right).	○	○	○	○	○
g. When I chew, my teeth hit where they should not hit.	○	○	○	○	○
h. When I bite down, my back teeth don't touch evenly.	○	○	○	○	○
i. My upper and lower back teeth fit together like they should (come together right).	○	○	○	○	○
j. I can chew food as well as I want to.	○	○	○	○	○
k. I can take bites of anything including apples or pizza.	○	○	○	○	○
l. When I smile, too much tooth or gum shows.	○	○	○	○	○
m. If I open my mouth wide, my jaw hurts.	○	○	○	○	○
n. My jaw moves sideways if I open my mouth all the way.	○	○	○	○	○
o. My jaw makes a grating or grinding noise when it opens or closes.	○	○	○	○	○
p. I can open my mouth as wide as I want to.	○	○	○	○	○
q. My jaw pops or clicks when I chew or open or close my mouth.	○	○	○	○	○

16264

Appendix 6. PSPOF page 2

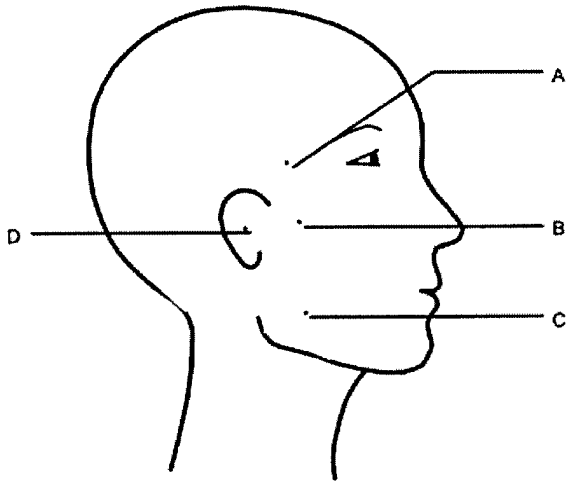
PSPOF - Page 2

ID NUMBER: ☐☐☐☐

PATIENT INITIALS: ☐☐☐

Instructions: Look at the picture below. Do you have any pain, discomfort, or soreness in any of these areas on either the right or the left side? Please FILL IN THE CIRCLE COMPLETELY for your answer.

a. Temples (A)	○ No	○ Yes	○ Don't Know
b. Jaw Joints (B)	○ No	○ Yes	○ Don't Know
c. Jaw Muscles (C)	○ No	○ Yes	○ Don't Know
d. Ears (D)	○ No	○ Yes	○ Don't Know



16264

Appendix 7. FI

UNIVERSITY OF NORTH CAROLINA
SCHOOL OF DENTISTRY
PATIENT PERCEPTION
FI - Orthodontics Only Recall

ID NUMBER: ☐☐☐☐
PATIENT INITIALS: ☐☐☐
DATE: ☐☐ / ☐☐ / ☐☐☐☐

Study: ● Ortho

Visit: ○ End of Ortho ○ ☐☐ Yrs Post-Treatment

Instructions: Consider each item listed below and FILL IN THE CIRCLE COMPLETELY which best represents your feelings about yourself at the present time.

	Have Strong Negative Feelings				Have Strong Positive Feelings
1. Hair	○	○	○	○	○
2. Ears	○	○	○	○	○
3. Forehead	○	○	○	○	○
4. Eyes	○	○	○	○	○
5. Nose	○	○	○	○	○
6. Lips	○	○	○	○	○
7. Mouth	○	○	○	○	○
8. Teeth	○	○	○	○	○
9. Facial Complexion	○	○	○	○	○
10. Chin	○	○	○	○	○
11. Neck	○	○	○	○	○
12. Profile	○	○	○	○	○
13. Eyebrows	○	○	○	○	○
14. Cheeks / Cheekbones	○	○	○	○	○
15. Smile	○	○	○	○	○
16. Facial Skin Tone	○	○	○	○	○

10535

Appendix 8. PAR Weightings

PAR Component	English weighting	American Weighting
Upper anterior score (UA)	X1	X1
Lower anterior score (LA)	X1	Not scored
Right buccal segment score (RB)	X1	X2
Left buccal segments score (LB)	X1	X2
Overjet score (OJ)	X6	X5
Overbite score (OB)	X2	X3
Centerline score (ML)	X4	X3
	Total English weighted score	Total American weighted score

Appendix 9. Descriptive Statistics for EWS for Final and Recall Camouflage Models

Final EWS			Recall EWS	
Mean	6		Mean	9.3
Standard Error	0.8		Standard Error	1.1
Median	4.5		Median	9.5
Mode	4		Mode	4
Standard Deviation	4.4		Standard Deviation	6
Sample Variance	19		Sample Variance	37
Kurtosis	-1		Kurtosis	3.2
Skewness	0.8		Skewness	1.3
Range	14		Range	28
Minimum	1		Minimum	2
Maximum	15		Maximum	30
Sum	181		Sum	280
Count	30		Count	30
Largest (1)	15		Largest (1)	30
Smallest (1)	1		Smallest (1)	2
Confidence Level (95.0%)	1.6		Confidence Level (95.0%)	2.3

Appendix 10. Intra-examiner reliability of total camouflage EWS

(19 out of 60 models reexamined 2 wk later)					Difference
Model Number		1st PAR score	2nd PAR score		
8		2	2		0
22		15	16		1
15		4	3		-1
50		4	5		1
59		4	5		1
61		12	12		0
35		6	4		-2
6		6	5		-1
11		8	8		0
84		30	30		0
55		12	11		-1
77		2	2		0
14		14	12		-2
75		3	3		0
41		1	1		0
81		4	4		0
4		11	12		1
87		13	13		0
48		16	15		-1
				Sum of difference	-4

Appendix 11. Individual Component PAR Scores on Final and Recall Camouflage Models

Subject Number	Initial Scores PAR score on Final model								Par score on Recall model							
	UA	LA	RB	LB	OJ	OB	ML	EWS	UA	LA	RB	LB	OJ	OB	ML	EWS
1	0	1	2	2	0	2	0	7	1	0	2	1	0	2	4	10
2	0	1	1	0	0	0	0	2	0	0	1	1	0	2	0	4
3	0	0	1	1	0	0	0	2	0	2	1	1	0	0	0	4
4	2	0	4	3	6	0	0	15	4	0	4	4	18	0	0	30
5	0	0	0	2	0	0	0	2	0	1	0	2	0	2	0	5
6	0	1	2	2	0	0	0	5	1	2	2	2	0	0	0	6
7	0	0	1	1	0	0	0	2	1	0	0	4	0	0	0	5
8	0	2	1	1	6	0	0	10	0	2	1	1	6	0	0	10
9	0	2	1	1	0	0	0	4	1	0	2	2	6	0	0	11
10	0	1	1	2	6	4	0	14	0	4	0	2	6	4	0	16
11	0	0	2	1	0	0	0	3	0	0	2	0	0	2	0	4
12	1	0	1	2	6	2	0	12	1	2	2	1	6	2	0	14
13	0	0	0	1	0	0	0	1	3	0	1	0	0	0	0	4
14	0	0	2	2	0	0	0	4	0	1	2	1	0	0	0	4
15	0	0	3	2	0	0	0	5	1	1	1	2	6	2	0	13
16	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0	2
17	0	0	2	2	0	0	0	4	0	1	1	0	0	0	0	2
18	0	0	2	2	0	0	0	4	0	0	3	2	6	0	0	9
19	0	2	1	2	6	0	0	11	1	5	0	2	0	0	0	8
20	1	0	1	1	0	0	0	2	2	1	2	3	6	2	0	16
21	0	0	2	3	0	0	0	5	1	1	2	2	6	2	0	14
22	1	0	2	2	6	0	4	15	1	0	1	1	6	0	4	13
23	0	1	0	0	0	0	0	1	0	0	2	0	0	0	0	2
24	0	0	2	2	0	0	0	4	1	2	1	1	6	0	0	11
25	1	0	2	3	6	0	0	12	1	2	1	1	6	2	0	13
26	0	1	3	2	0	0	0	6	0	0	2	2	0	0	0	4
27	1	0	1	2	6	0	0	10	0	2	2	2	6	0	4	16
28	1	1	2	2	0	0	0	6	1	6	2	1	0	2	0	12
29	0	0	1	1	6	0	0	8	0	2	2	2	6	0	0	12

Subject Number	Repeat Scores PAR score on Final model								Par score on Recall model							
	UA	LA	RB	LB	OJ	OB	ML	EWS	UA	LA	RB	LB	OJ	OB	ML	EWS
1																
2																
3	0	0	1	1	0	0	0	2								
4	3	0	4	3	6	0	0	16	4	0	4	4	18	0	0	30
5																
6																
7	0	0	1	1	0	0	0	2								
8																
9																
10	0	1	1	2	6	2	0	12								
11	0	0	2	1	0	0	0	3								
12																
13																
14	0	0	1	2	0	0	0	3								
15									1	1	1	2	6	2	0	13
16	0	1	0	0	0	0	0	1								
17	0	0	2	2	0	0	0	4								
18	0	0	3	2	0	0	0	5								
19	0	3	1	2	6	0	0	12								
20									1	1	2	3	6	2	0	15
21																
22																
23																
24	0	1	2	2	0	0	0	5								
25	1	0	2	3	6	0	0	12								
26	0	0	2	2	0	0	0	4								
27																
28	1	1	1	2	0	0	0	5								
29	0	0	1	1	6	0	0	8	0	2	2	1	6	0	0	11

UA = upper arch	RB = Right Buccal	OJ = Overjet	ML = Midline
LA = Lower arch	LB = Left Buccal	OB = Overbite	EWS = English Weighted Score

Appendix 12. Reliability Table for PAR components on camouflage patients

	Raw Agreement	Weighted Kappa
Upper Arch	17/19 89%	0.89
Lower Arch	16/19 84%	0.84
Right Buccal	15/19 79%	0.80
Left Buccal	18/19 95%	0.94
Overjet	19/19 100%	1.0
Overbite	18/19 95%	0.94
Midline	19/19 100%	1.0

Appendix 13. Photo PAR scores of camouflage patients, repeated 2 weeks apart.

Photo PAR score

	PAR score on Recall pictures (1st)								PAR score on Recall pictures (repeat)							
pt #	UA	LA	RB	LB	OJ	OB	ML	EWS	UA	LA	RB	LB	OJ	OB	ML	EWS
57	1	0	1	2		0	4	8	1	0	1	2		0	4	8
47	0	1	1	1		2	0	5	0	1	1	1		2	0	5
24	1	2	0	0		0	0	3	1	1	1	0		0	0	3
84	4	0	2	1		0	0	7	3	0	2	1		0	0	6
60	0	2	1	0		0	0	3	0	2	1	0		0	4	7
42	1	0	0	1		0	0	2	1	0	0	1		2	0	4
33	1	1	0	1		2	0	5	1	1	0	1		2	0	5
78	1	2	2	2		0	0	7	1	2	1	2		0	0	6
82	0	5	1	2		6	0	14	0	5	1	2		6	0	14
39	0	1	1	0		2	0	4	1	0	1	0		2	0	4
40	2	0	0	0		0	0	2	2	0	0	0		0	0	2
87	1	3	1	2		2	0	9	1	3	1	2		2	0	9
51	1	1	0	0		0	0	2	1	0	0	0		0	0	1
1	1	0	1	1		0	0	3	1	0	1	1		0	0	3
31	1	3	0	1		2	0	7	1	3	0	0		2	0	6
48	4	3	2	1		4	0	14	4	3	2	1		4	0	14
85	1	3	1	2		0	0	7	0	3	1	2		0	0	6
70	2	1	1	2		0	4	10	2	1	1	2		0	4	10
43	0	0	1	0		0	0	1	0	0	1	0		0	0	1
7	0	4	0	1		2	0	7	0	4	0	1		2	0	7
9	0	2	1	2		2	0	7	0	4	1	2		2	0	8
72	1	3	1	1		2	0	8	1	3	1	1		2	0	8
32	1	0	1	2		0	0	4	1	0	1	2		0	0	4
83	0	1	2	2		0	4	9	0	1	2	2		0	0	5
3	1	6	0	0		2	0	9	1	6	0	0		2	0	9
55	0	2	0	0		0	0	2	0	2	0	0		0	0	2

Appendix 14. Reliability Table for Photo PAR components on camouflage patients

	Raw Agreement	Weighted Kappa
Upper Arch	22/26 85%	0.89
Lower Arch	22/26 85%	0.89
Right Buccal	24/26 92%	0.88
Left Buccal	25/26 96%	0.95
Overbite	25/26 96%	0.95
Midline	24/26 92%	0.88
English Weighted Score		0.93
Unweighted SUM		0.97

Appendix 15. Reliability Table for Final Pictures and Recall Pictures on Surgery Patients.

	Raw Agreement	Reliability
UA final	11/14 79%	0.59
LA final	11/14 79%	0.89
RB final	14/14 100%	1.00
LB final	14/14 100%	1.00
OJ Final	13/14 93%	0.67
OB final	14/14 100%	1.00
ML final	14/14 100%	1.00
EWS final	T value –0.81 p = 0.43	0.97
Unweighted SUM final		0.94
UA recall	11/14 79%	0.83
LA recall	11/14 79%	0.94
RB recall	13/14 93%	0.95
LB recall	13/14 93%	0.95
OJ recall	13/14 93%	0.86
OB recall	14/14 100%	1.00
ML recall	14/14 100%	1.00
EWS recall	T value –1, p = 0.34	0.99
Unweighted SUM recall		0.98

Appendix 16. Model versus Photo PAR scores on Camouflage patients.

Subject Number	Initial scoring on Model Par score on Recall model								New EWS score if remove OJ		Photo PAR score PAR score on Recall pictures							
	UA	LA	RB	LB	OJ	OB	ML	EWS			UA	LA	RB	LB	OJ	OB	ML	EWS
1	1	0	2	1	0	2	4	10	10		1	0	1	2	N/A	0	4	8
2	0	0	1	1	0	2	0	4	4		0	1	1	1	N/A	2	0	5
3	0	2	1	1	0	0	0	4	4		1	2	0	0	N/A	0	0	3
4	4	0	4	4	18	0	0	30	12		4	0	2	1	N/A	0	0	7
5	1	2	2	2	0	0	0	7	7		0	2	1	0	N/A	0	0	3
6	1	0	0	4	0	0	0	5	5		1	0	0	1	N/A	0	0	2
7	0	2	1	1	6	0	0	10	4		1	1	0	1	N/A	2	0	5
8	1	0	2	2	6	0	0	11	5		1	2	2	2	N/A	0	0	7
9	0	4	0	2	6	4	0	16	10		0	5	1	2	N/A	6	0	14
10	1	2	2	1	6	2	0	14	8		0	1	1	0	N/A	2	0	4
11	3	0	1	0	0	0	0	4	4		2	0	0	0	N/A	0	0	2
12	1	1	1	2	6	2	0	13	7		1	3	1	2	N/A	2	0	9
13	2	0	0	0	0	0	0	2	2		1	1	0	0	N/A	0	0	2
14	0	0	3	2	6	0	0	11	5		1	0	1	1	N/A	0	0	3
15	1	5	0	2	0	0	0	8	8		1	3	0	1	N/A	2	0	7
16	2	1	2	3	6	2	0	16	10		4	3	2	1	N/A	4	0	14
17	1	1	2	2	6	2	0	14	8		1	3	1	2	N/A	0	0	7
18	1	0	1	1	6	0	4	13	7		2	1	1	2	N/A	0	4	10
19	0	0	2	0	0	0	0	2	2		0	0	1	0	N/A	0	0	1
20	1	2	1	1	6	0	0	11	5		0	2	1	2	N/A	2	0	7
21	1	2	1	1	6	2	0	13	7		1	3	1	1	N/A	2	0	8
22	0	0	2	2	0	0	0	4	4		1	0	1	2	N/A	0	0	4
23	0	2	2	2	6	0	4	16	10		0	1	2	2	N/A	0	4	9
24	1	6	2	1	0	2	0	12	12		1	6	0	0	N/A	2	0	9
25	0	2	2	2	6	0	0	12	6		0	2	0	0	N/A	0	0	2

UA = upper arch	RB = Right Buccal	OJ = Overjet	ML = Midline
LA = Lower arch	LB = Left Buccal	OB = Overbite	EWS = English Weighted Score

Appendix 17. Reliability for model versus the photo components on camouflage patients.

	Raw Agreement	Reliability
Upper Arch	15/26 58%	0.75
Lower Arch	13/26 50%	0.80
Right Buccal	11/26 42%	0.28
Left Buccal	12/26 46%	0.22
OverBite	18/26 69%	0.66
Midline	26/26 100%	1.0
English Weighted Score		0.68
Unweighted SUM		0.59

Appendix 18. Univariate for Difference in English Weighted Total Par Score

The UNIVARIATE Procedure

Variable: Difference in English Weighted Scores (dews)

Moments

N	29	Sum Weights	29
Mean	3.34482759	Sum Observations	97
Std Deviation	4.35296173	Variance	18.9482759
Skewness	1.09383643	Kurtosis	1.30737432
Uncorrected SS	855	Corrected SS	530.551724
Coeff Variation	130.140093	Std Error Mean	0.8083247

Basic Statistical Measures

Location		Variability	
Mean	3.344828	Std Deviation	4.35296
Median	2.000000	Variance	18.94828
Mode	1.000000	Range	18.00000
		Interquartile Range	5.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.137975	Pr > |t|	0.0003
Sign	M	9.5	Pr >= |M|	0.0003
Signed Rank	S	147	Pr >= |S|	<.0001

Quantiles (Definition 5)

Quantile	Estimate
100% Max	15
99%	15
95%	14
90%	9
75% Q3	6
50% Median	2
25% Q1	1

Appendix 19. Component PAR Scores on Final and Recall Pictures on Surgical Patients.

Subject Number	Initial scoring																
	PAR score on Final picture									Par score on Recall picture							
	UA	LA	RB	LB	OJ	OB	ML	EWS		UA	LA	RB	LB	OJ	OB	ML	EWS
1	1	0	2	1	<4	0	0	4		1	0	2	1	<4	0	0	4
2	1	0	2	2	>4	0	0	5		1	3	2	2	>4	2	4	14
3	0	0	2	0	<4	0	0	2		1	0	2	0	<4	0	0	3
4	1	0	2	2	>4	0	0	5		2	2	1	3	>4	0	4	12
5	0	3	0	0	<4	2	4	9		0	3	0	0	>4	2	4	9
6	1	1	2	2	>4	0	0	6		0	2	0	1	>4	2	0	5
7	0	3	2	0	>4	2	4	11		0	1	2	0	<4	2	4	9
8	1	1	2	2	<4	2	0	8		2	1	0	1	>4	2	0	6
9	1	1	0	0	<4	0	0	2		0	3	0	0	<4	0	0	3
10	0	0	0	0	<4	0	0	0		1	3	0	0	<4	2	0	6
11	0	0	1	1	>4	2	0	4		1	0	1	1	<4	0	0	3
12	0	0	2	1	<4	0	0	3		1	2	2	1	<4	0	4	10
13	0	1	2	2	<4	2	0	7		0	4	1	2	>4	4	0	11
14	1	0	0	1	<4	0	0	2		1	0	0	0	<4	0	0	1

Subject Number	Repeat Photo PAR score																
	PAR score on Final picture									Par score on Recall picture							
	UA	LA	RB	LB	OJ	OB	ML	EWS		UA	LA	RB	LB	OJ	OB	ML	EWS
1	0	0	2	1	<4	0	0	3		1	0	2	1	<4	0	0	4
2	1	1	2	2	>4	0	0	6		1	3	2	2	>4	2	4	14
3	0	0	2	0	<4	0	0	2		1	0	2	0	<4	0	0	3
4	1	0	2	2	>4	0	0	5		2	2	1	3	>4	0	4	12
5	0	2	0	0	<4	2	4	8		0	3	0	0	>4	2	4	9
6	1	1	2	2	<4	0	0	6		0	1	0	1	>4	2	0	4
7	0	3	2	0	<4	2	4	11		0	1	2	0	<4	2	4	9
8	1	1	2	2	<4	2	0	8		3	0	0	1	>4	2	0	6
9	0	1	0	0	<4	0	0	1		0	3	0	0	<4	0	0	3
10	0	0	0	0	<4	0	0	0		0	3	0	0	<4	2	0	5
11	1	0	1	1	>4	2	0	5		0	0	1	1	<4	0	0	2
12	0	0	2	1	<4	0	0	3		1	2	2	1	>4	0	4	10
13	0	0	2	2	<4	2	0	6		0	3	2	2	>4	4	0	11
14	1	0	0	1	<4	0	0	2		1	0	0	1	<4	0	0	2

Appendix 20. Descriptive Statistics for EWS for Surgical Final and Recall pictures.

Final EWS			*Recall EWS*	
Mean	4.9		Mean	6.9
Standard Error	0.8		Standard Error	1.1
Median	4.5		Median	6
Standard Deviation	3.1		Standard Deviation	4
Kurtosis	-0.3		Kurtosis	-1.1
Skewness	0.5		Skewness	0.3
Range	11		Range	13
Minimum	0		Minimum	1
Maximum	11		Maximum	14
Largest(1)	11		Largest(1)	14
Smallest(1)	0		Smallest(1)	1

Appendix 21. PAR Descriptive Statistics Recall minus Final change.

Variable	N	Mean	STD Dev	Min	Max	T Value	Pr > /t/ * = <0.05
Surgery Patients							
UA	14	0.29	0.73	-1.0	1.0	1.47	0.1648
LA	14	1.00	1.52	-2.0	3.0	2.46	0.0285*
RB	14	-0.43	0.76	-2.0	0.0	-2.12	0.0537
LB	14	-0.14	0.53	-1.0	1.0	-1.00	0.3356
OJ	14	0.07	0.62	-1.0	1.0	0.43	0.6714
OB	14	0.21	0.58	-1.0	1.0	1.38	0.1894
ML	14	0.21	0.43	0.0	1.0	1.88	0.0823
EWS	14	2.0	3.80	-2.0	9.0	1.97	0.0708
Unweighted SUM	14	1.21	2.72	-3.0	5.0	1.67	0.1190
Camo Patients							
UA	29	0.52	0.83	-1.0	3.0	3.36	0.0023*
LA	29	0.79	1.52	-2.0	5.0	2.81	0.0090*
RB	29	-0.03	0.91	-2.0	2.0	-0.21	0.8390
LB	29	-0.14	1.09	-2.0	3.0	-0.68	0.5023
OJ	29	1.45	3.46	-6.0	12.0	2.25	0.0322*
OB	29	0.55	0.91	0.0	2.0	3.27	0.0029*
ML	29	0.28	1.03	0.0	4.0	1.44	0.1609
EWS	29	3.34	4.35	-3.0	15.0	4.14	0.0003*
Unweighted SUM							

Note:

Surgery Patients based on Recall Picture PAR – Final Picture PAR

Camouflage Patients based on Recall Model PAR – Final Model PAR

Appendix 22. Univariate for the Difference in English Weighted Total PAR Score for surgical patients.

The UNIVARIATE Procedure
Variable: cews

Moments

N	14	Sum Weights	14
Mean	2	Sum Observations	28
Std Deviation	3.80283295	Variance	14.4615385
Skewness	0.7147527	Kurtosis	-1.0836454
Uncorrected SS	244	Corrected SS	188
Coeff Variation	190.141648	Std Error Mean	1.01634986

Basic Statistical Measures

Location		Variability	
Mean	2.00000	Std Deviation	3.80283
Median	0.50000	Variance	14.46154
Mode	-1.0000	Range	11.00000
		Interquartile Rang	7.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.967826	Pr > |t|	0.0708
Sign	M	1	Pr >= |M|	0.7744
Signed Rank	S	17	Pr >= |S|	0.1890

Quantiles (Definition 5)

Quantile	Estimate
100% Max	9.0
99%	9.0
95%	9.0
90%	7.0
75% Q3	6.0
50% Median	0.5

Appendix 23. Comparison of Adult Camouflage to Long Term Surgical Studies.

Appendix 23	Comparison of Adult Camouflage to Long Term Surgical Studies (Schubert et al, ref 6)			
	Factors affecting significance (Analysis of Covariance)			
Measurement	Age	Follow-up length	Groups	Differences between groups
Horizontal Changes				
ANS	Y (p=0.0480)	N	Y (p=0.0284)	diff is b/w 2J +CM (p= 0.0316); CM + PS (p=0.0316)
A pt	N	N	Y (p=0.0353)	No diff is significant
B pt	Y (p=0.0160)	Y (p=0.0121)	Y (p=0.0085)	diff is b/w 2J +PS (p= 0.0100)
Pg	Y (p=0.0133)	Y (p=0.0240)	Y (p=0.0003)	diff is b/w 2J + CM (p= 0.0145); 2J +PS (p= 0.0007)
max incisor	N	N	N	
mand incisor	N	N	Y (p=0.0034)	diff is b/w 2J + CM (p= 0.0256); 2J +PS (p= 0.0091)
Vertical Changes				
A pt	N	N	Y (p= 0.0187)	No diff is significant
B pt	N	N	Y (p=0.0156)	diff is b/w 2J + Md (p= 0.0222); Mx + Md (p= 0.0321)
Pg	Y (p= 0.0181)	N	Y (p= 0.0344)	diff is b/w 2J + Md (p= 0.0311)
Me	Y (p>0.0001)	N	Y (p= 0.0067)	diff is b/w Mx + Md (p= 0.0064)
max incisor	Y (p=0.0040)	N	Y (p=0.0167)	diff is b/w Mx + Md (p= 0.0165)
mand incisor	Y (p=0.0089)	N	Y (p= 0.0342)	diff is b/w Mx + Md (p= 0.0233)
Dimensional Changes				
Overjet	N	N	Y (p=0.0086)	diff is b/w Md + PS (p= 0.0069) and Mx + Md (p= 0.0225)
Overbite	Y (p= 0.0389)	Y (p=0.0090)	N	

N = not significant, Y= significant (P < 0.05).
Groups = 2 Jaw (2J), Max surg (Mx), Mand Surg (Md), Camouflage (CM) or Schubert's non-surg group (PS).

Appendix 24. Demographic Characteristics of Camouflage Patients

	n	Mean	SD	Range
Camouflage group	31			
Initial age (y)		28.6	8.6	16 to 46.3
Follow-up length (y)		12.0	2.8	6.5 to 15.7
Gender				
Female	30 (97%)			
Male	1 (3%)			

Camouflage Patients Extraction Patterns (n= 31)	
Conventional camouflage extraction of U4's only or U4's and L5's	10
Asymmetric Premolar extraction	6
U4/L4's or U5/L5's	10
Incisors	3
Primary Molars	1
U6's	1

Appendix 25. Percentage of Change for Patients PAR Score from Final to Recall:

PERCENTAGE OF PATIENTS FOR WHOM PAR SCORE DID OR DID NOT CHANGE FROM FINAL TO RECALL				
	No Change	**Improved Score**	**Worse (by one unit)**	**Lots worse (greater than 1 unit)**
Camouflage				
Upper Arch	**55%**	**3%**	**31%**	**10%**
Lower Arch	**24%**	**21%**	**24%**	**31%**
Right Buccal	**41%**	**31%**	**24%**	**3%**
Left Buccal	**41%**	**38%**	**14%**	**7%**
Overjet	**73%**	**3%**	**24%**	**0%**
Overbite	**73%**	**0%**	**27%**	**0%**
Midline	**93%**	**0%**	**7%**	**0%**
Surgery				
Upper Arch	**43%**	**14%**	**43%**	**0%**
Lower Arch	**43%**	**7%**	**7%**	**43%**
Right Buccal	**71%**	**29%**	**0%**	**0%**
Left Buccal	**79%**	**21%**	**7%**	**0%**
Overjet	**64%**	**14%**	**7%**	**N/A**
Overbite	**64%**	**7%**	**29%**	**0%**
Midline	**79%**	**0%**	**21%**	**0%**

Note: Surgical patients OJ was scored <4mm = 0, >4mm = 1, therefore no change could have been greater than 1 unit.

Appendix 26. PAR Descriptive Statistics Recall minus Final change.

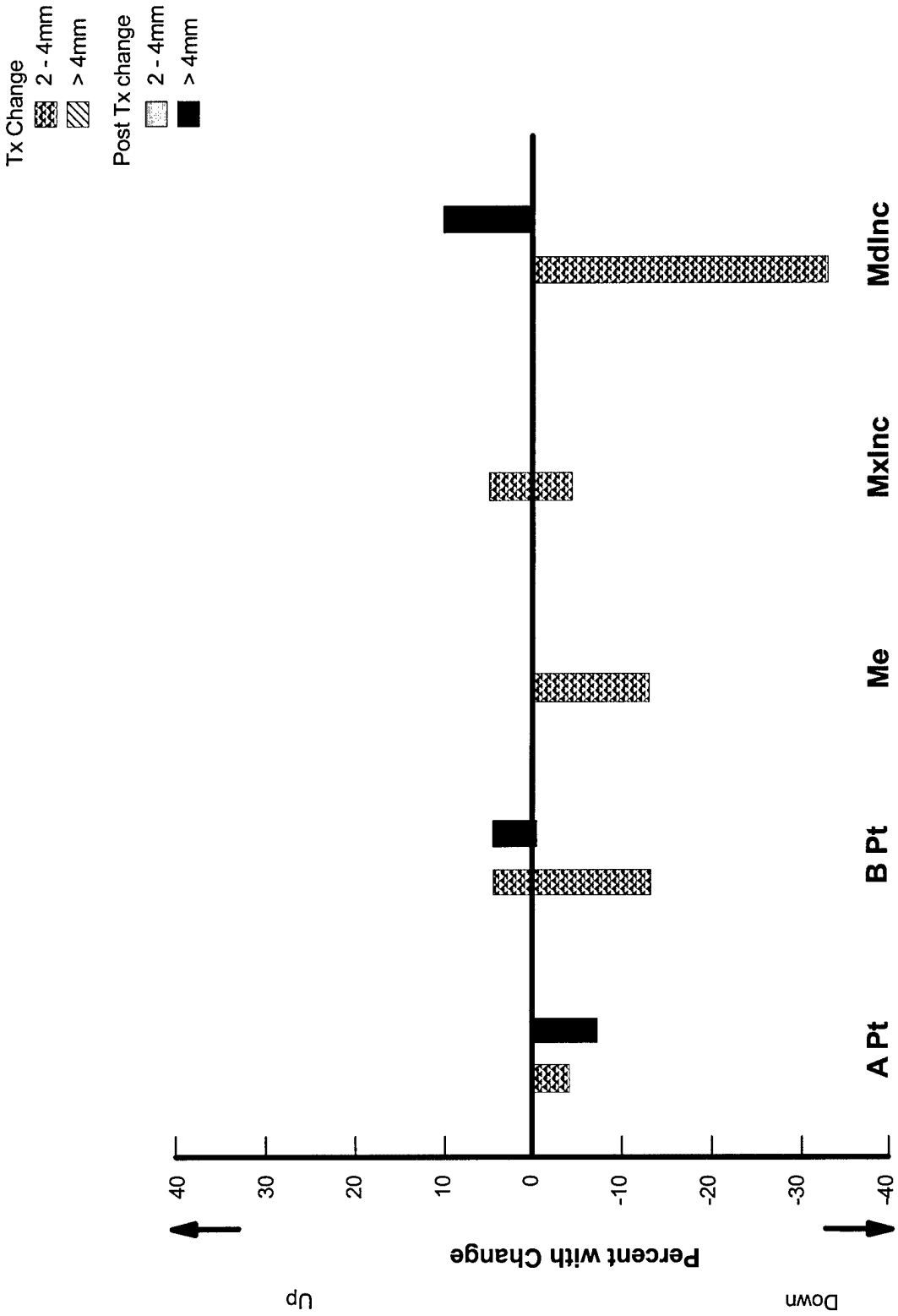
Variable	N	Mean	STD Dev	Min	Max	T Value	Pr > /t/ * = <0.05
Surgery Patients							
UA	14	0.29	0.73	-1.0	1.0	1.47	0.1648
LA	14	1.00	1.52	-2.0	3.0	2.46	0.0285*
RB	14	-0.43	0.76	-2.0	0.0	-2.12	0.0537
LB	14	-0.14	0.53	-1.0	1.0	-1.00	0.3356
OJ	14	0.07	0.62	-1.0	1.0	0.43	0.6714
OB	14	0.21	0.58	-1.0	1.0	1.38	0.1894
ML	14	0.21	0.43	0.0	1.0	1.88	0.0823
EWS	14	2.0	3.80	-2.0	9.0	1.97	0.0708
Unweighted SUM	14	1.21	2.72	-3.0	5.0	1.67	0.1190
Camo Patients							
UA	29	0.52	0.83	-1.0	3.0	3.36	0.0023*
LA	29	0.79	1.52	-2.0	5.0	2.81	0.0090*
RB	29	-0.03	0.91	-2.0	2.0	-0.21	0.8390
LB	29	-0.14	1.09	-2.0	3.0	-0.68	0.5023
OJ	29	1.45	3.46	-6.0	12.0	2.25	0.0322*
OB	29	0.55	0.91	0.0	2.0	3.27	0.0029*
ML	29	0.28	1.03	0.0	4.0	1.44	0.1609
EWS	29	3.34	4.35	-3.0	15.0	4.14	0.0003*
Unweighted SUM							

Note:

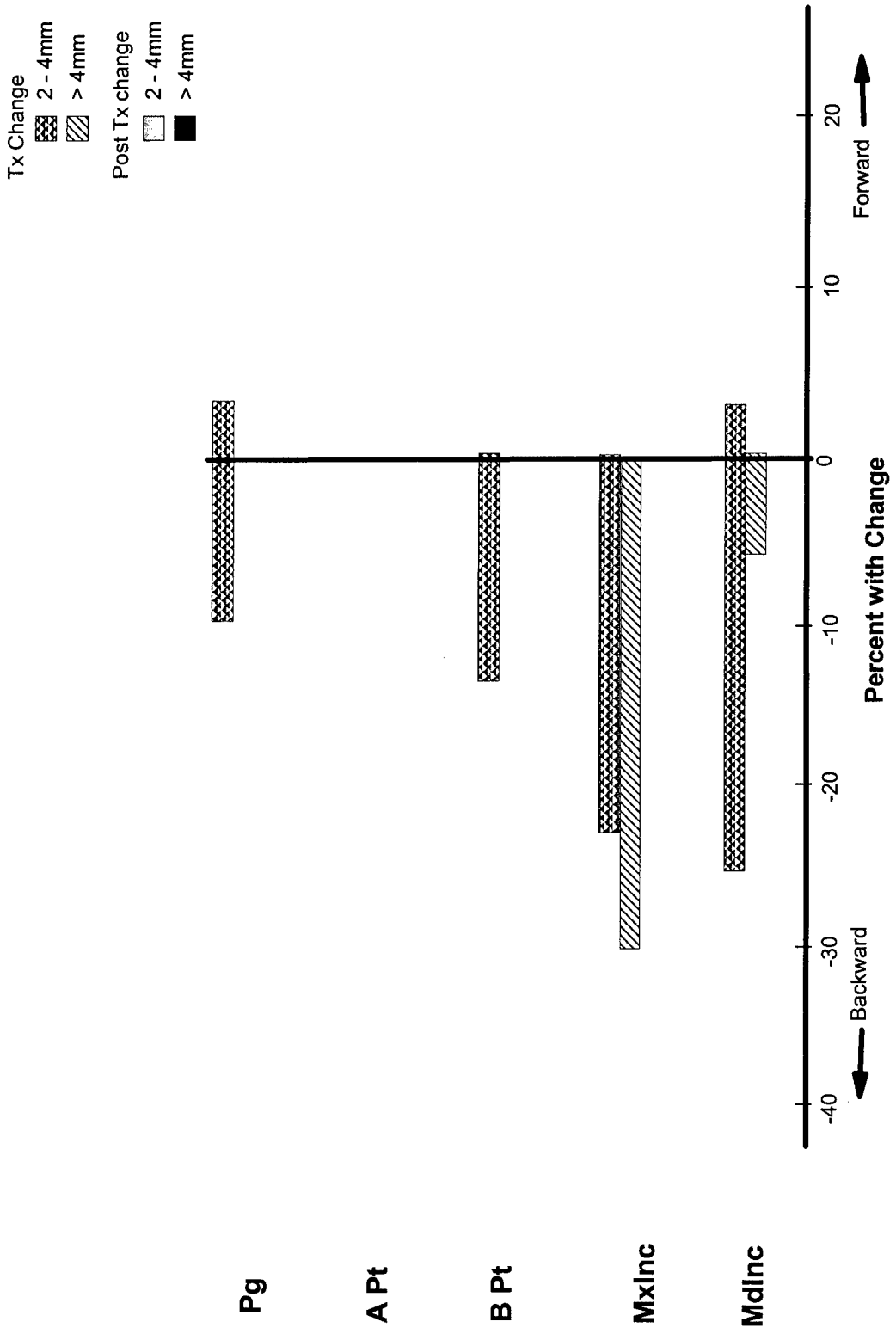
Surgery Patients based on Recall Picture PAR – Final Picture PAR

Camouflage Patients based on Recall Model PAR – Final Model PAR

Appendix 27. Camouflage Vertical Changes



Appendix 28. Camouflage Horizontal Changes



Appendix 29. Camouflage Dimensional Changes